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FOOD HABITS OF THE GROSBEAKS

BY

W. L. McATEE

ASSISTANT, BIOLOGICAL SURVEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1908

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CARDINAL AND GRAY GROSBEAKS.

[Top figure, male cardinal; middle figure, male gray grosbeak; bottom figure, female cardinal.]

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., November 1, 1907.

Sir: I have the honor to transmit herewith for publication as Bulletin No. 32 of the Biological Survey a report on the food habits of the grosbeaks, by W. L. McAtee. The grosbeaks are a small group of finches, hitherto more widely appreciated for their bright plumage, sweet song, and attractiveness as cage birds than for their services to agriculture. These are here shown to be of such character as to entitle the several members of the group to every consideration at the hands of the farmer.

The illustrations which accompany this paper are considered essential to a proper understanding of the text.

Respectfully,

H. W. Henshaw,
Acting Chief Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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FOOD HABITS OF THE GROSBEAKS.

INTRODUCTION.

Two distinct groups of finches or sparrows are commonly known as grosbeaks. One of these, which includes the pine and evening grosbeaks, is of little practical importance, since its members breed and pass most of their lives in mountainous regions, or in the northern parts of North America. The other group includes the cardinal, gray, rose-breasted, black-headed, and blue grosbeaks, which spend either the summer or the entire year within agricultural regions of the United States. Hence their food habits are of considerable importance to the farmer.

The members of the first-named group may be dismissed with the statement that during the period when they occur in non-mountainous districts their food consists largely of wild seeds and berries. Apparently the best relished are those of mountain ash, choke cherry, box elder, white ash, and maple, and of spruce, red cedar, and other coniferous trees. The food habits of the second group are treated in detail in the following pages.

CARDINAL.

(*Cardinalis cardinalis.* Plate I, Frontispiece.)

DISTRIBUTION AND HABITS.

The brilliant and easily recognized cardinal ranges over much of North America. It occurs from southernmost Mexico and northern Central America north to New York, Ontario, and northern Iowa, and west to central Kansas, Arizona, and Lower California. In parts of this area the size and color have been so modified by climatic and other causes that 12 varieties or subspecies are distinguishable. Five of these reside in the United States, and while they bear no distinctive vernacular names, the species as a whole is well supplied, being variously known as cardinal grosbeak or cardinal, Virginia nightingale, redbird, and also as the crested or topknot redbird, in distinction from the summer redbird or tanager.

The cardinal is resident wherever found; that is, the neighborhood where the bird rears its young is its home throughout the year. It is most abundant perhaps in the Southern States, where almost univer-

sally it is known as the redbird, and is often kept as a household pet. Affection for the bird, however, is not confined to the South, for its loud, ringing song, bright plumage, and vivacious manner make it a favorite wherever it lives. When winter's snows cover its favorite feeding grounds the redbird becomes bolder and seeks its fare about sheds and barns and even among the horses' feet. Spring returning, its natural food supplies are once more available, and then the cardinal mostly frequents hedges, fence rows, and brushy thickets. The cardinal is one of the few birds which sings throughout the year, although, of course, its songs are rendered more frequently and in greater perfection during the breeding season.

The nest is loosely built and generally is placed in a bush or vine, often in the densest tangles; in it three or four speckled eggs are laid. The first set of eggs usually is completed in May, but the second clutch is sometimes postponed until late summer. The cardinal is very sensitive to any interference in its domestic affairs, and unfinished nests and even those containing full complements of eggs are deserted upon slight provocation. Hence one who would have cardinals for neighbors must see to it that the birds' privacy is undisturbed. The male redbird is a model parent, rushing to the defense of the nest in every emergency, doing a great share of the feeding and otherwise caring for the young. The first birds of the year usually begin to shift for themselves about midsummer.

The nest of the redbird is often within a few feet of the ground, and this circumstance leads to the destruction of many sets of eggs and broods of young by snakes, cats, and prowling wild mammals. Hence the bird needs protection, and when this is afforded it easily maintains its numbers.

ECONOMIC RELATIONS.

As mentioned above, the cardinal has ever been a favorite cage bird, and in some localities in the south great numbers have been trapped and sold into captivity. In times past it has suffered greatly also from the persecution of millinery collectors. Despite legal enactments against the killing of birds for hat gear, even yet the practice has by no means ceased, and among other useful birds the cardinal still suffers to a greater or less degree. In the District of Columbia cardinals were noted on hats as late as 1906.

The extent of the former traffic in wild birds for cage purposes was remarkable. "Thousands of mockingbirds, cardinals, indigo birds, and other bright-plumaged species were formerly trapped for sale in this country and abroad, and so assiduously did the bird trappers ply their vocation that in some localities these species were almost exterminated."[a]

[a] T. S. Palmer, Yearbook, Department of Agriculture, 1905, pp. 557–558.

Referring to the cardinal in particular. Nuttall[a] makes the statement:

> So highly were these birds esteemed for their melody that, according to Gemelli Carreri [who wrote in 1699], the Spaniards of Havana, in a time of public distress and scarcity, bought so many of these birds * * * that the sum expended, at ten dollars apiece, amounted to no less that 18,000 dollars.

The liking of the islanders for this bird has suffered no abatement in later days, according to W. E. D. Scott,[b] who wrote in 1889: "The cardinal is in great demand as a pet by the Cubans, and on that account is a regular feature of the auction rooms, being supplied from the northern keys and the mainland" [of Florida]. However, recent laws, while they have not wholly put an end to these baneful practices, have greatly restricted them, and the cardinal, along with other insectivorous birds, is nowadays comparatively well protected.

That from an economic standpoint the bird deserves complete protection, the following discussion of its food habits will make clear. Four hundred and ninety-eight stomachs of this species have been examined. They were collected during every month of the year and in twenty States, the District of Columbia, and Ontario. But for the fact that this material is unevenly distributed, seasonally and geographically, the results obtained from its examination would be perfectly satisfactory. As it is, Texas is much more completely represented than any other State, and May than any month, while the feeding habits for June and October are known only from examination of a very small number of stomachs. These conditions necessarily affect the results, but in view of the large number of stomachs, it is believed that a fairly correct idea of the normal food habits of the species has been obtained. As a result of our investigations it appears that, for each of the twelve months, the cardinal averages 28.99 percent of animal food and 71.01 percent of vegetable. The maximum percentage of animal food for any one month is 78.4, being the average for 123 birds taken in May. The minimum is 4.9 for 41 birds in January.

Vegetable Food.

It is generally stated that the cardinal is largely, if not entirely, vegetarian. While this statement is perhaps too strong, the result of the present investigation leaves no doubt that vegetable products compose the redbird's main subsistence at nearly all times of the year. In only one month do they constitute less than half the food, while for the entire year they average 71.01 percent. Grain amounts to 8.73 percent; wild fruit, only the seeds of which are usually eaten, composes 24.17 percent; weed and other seeds 36.38 percent, and miscellaneous vegetable substances 1.73 percent.

---

[a] Manual of Ornithology, The Land Birds, 1832, p. 525.

[b] Auk. VI, 1889, p. 324, quoting Atkins.

GRAIN.

A little more than 7.1 out of a total of 8.73 percent of grain eaten by the cardinal grosbeak is corn, while other cereals, including wheat, oats, sorghum, and rice, constitute the remaining 1.62 percent. Eleven birds had eaten oats, 4 wheat, 2 sorghum, and 1 rice, but so trifling is the percentage of these grains that practically no damage is done except under very unusual conditions, such as the concentration of a great number of redbirds in a small area; but this is improbable, because the redbird usually is nongregarious.

In regard to corn, however, which was eaten by 68 of the birds examined, more extended consideration is desirable. The redbird's fondness for Indian corn is noted by many writers, but extensive injury to the crop is charged by very few. Leverett M. Loomis,[a] in writing of the birds of South Carolina, says the cardinal is "held in considerable ill repute because of its alleged depredations on newly planted corn." A correspondent in Alabama writes that the redbird is injurious to corn in the roasting-ear stage, and that it also "pulls the corn in the spring when it is just up with two or three leaves." Little direct evidence concerning the redbird's depredations on corn is derivable from our examinations, because none of the birds studied were collected in newly planted fields or where corn was exposed to attack. It should be stated, however, that during March, April, and May, which months cover the planting seasons from southernmost United States to Canada, less than the average amount of corn is consumed. Corn constitutes a greater proportion of the food in January than in any other month, and practically all eaten at this season is waste. So also in November and December, when corn makes up 4 and 7 percent, respectively. Waste grain is often eaten in spring and even in midsummer, according to observations by the writer.

The cardinal is said to bore into grain stacks and also to visit corncribs in winter, but probably it does so only under stress of unusual circumstances, as deep snow, and in all likelihood the damage is trivial. Lining the crib with medium-meshed wire netting, which can be done at small cost, will prevent access by the birds, and at the same time guard against attacks of rodents and poultry, while in no way interfering with the necessary ventilation.

Considerable corn is eaten by the redbird during June, July, and August, and a portion of this may be pilfered from the standing crop. At this season, however, the birds are scattered, and it is not likely that much damage results in any one locality.

From the above it appears that present evidence does not suffice to determine the exact relation of the redbird to the corn crop, although, so far as it goes, it is in the bird's favor. To summarize:

[a] Auk. VII, 1890, p. 125.

Very few complaints have been made of attacks on corn by the redbird. Though this evidence is negative, it possesses some weight, since accusations against serious grain pests are always numerous and emphatic. The greatest proportion of corn is eaten in winter, hence is waste; and finally, the redbird does not flock habitually, and never at a season when corn is exposed to attack. For these reasons it may be concluded that the cardinal's depredations on corn are of little consequence.

WILD FRUIT.

Wild fruit, or rather the seeds of wild fruit, pulp being present in very few stomachs, was eaten by 312 of the redbirds examined, and, with the exception of weed seeds, is the largest item of the vegetable food. Of all fruits wild grapes are most important. From November to April their seeds constitute 17 percent of the cardinal's fare. They were eaten by 178 birds and in every month, forming on the average 11.9 percent of the subsistence throughout the year. Three species, the summer grape (*Vitis aestivalis*, Pl. II, fig. 8), the frost grape (*V. cordifolia*), and the bullace or southern fox grape (*V. rotundifolia*) were identified, and there is no doubt that the redbird feeds upon all kinds of wild grapes growing within its range. Although wild grapes are such favorite food, they seldom are swallowed whole, only one or two entire grapes being found in the stomachs. Further, very few entire seeds are swallowed. The seeds are generally crushed and ground by the powerful beak into such small bits that their identification is very difficult.

The presence of great numbers of fruit seeds with little or no pulp is accounted for by well-known habits of the bird. It searches continually among leaves and rubbish on the ground, where it secures many of the seeds and shriveled fruits. It also gathers dried berries from the vines in winter.

The fruits of various dogwoods rank next to grapes in the redbird's regimen. They were eaten by 52 birds and constitute 3.97 percent of the total food examined. Rough-leaved (Pl. II, fig. 6) and flowering dogwood (Pl. II, fig. 5) seeds were identified. Any one familiar with the intense bitterness of these fruits will admit that the cardinal possesses considerable individuality of taste.

All fruits united, other than cornel berries and grapes, form 8.3 percent of the annual food. Most important among them are blackberries and raspberries, which were eaten by 34 birds. Mulberries were eaten by 31, and hackberries by 23 redbirds. Among the latter fruits two species were identified—the common hackberry or sugar berry (*Celtis occidentalis*, Pl. II, fig. 2) and the southern hackberry (*C. mississippiensis*). The last named was eaten by nearly 20 cardinals collected in one locality in Texas. Smilax seeds, iden-

tified as of the bristly or bamboo greenbrier (*Smilax bona-nox*), which are almost as hard as wood, were taken by 2 individuals. It would be well for humankind if more birds were fond of the seeds of these detestable vines. One cardinal ate seeds of Solomon's seal (*Polygonatum biflorum*).

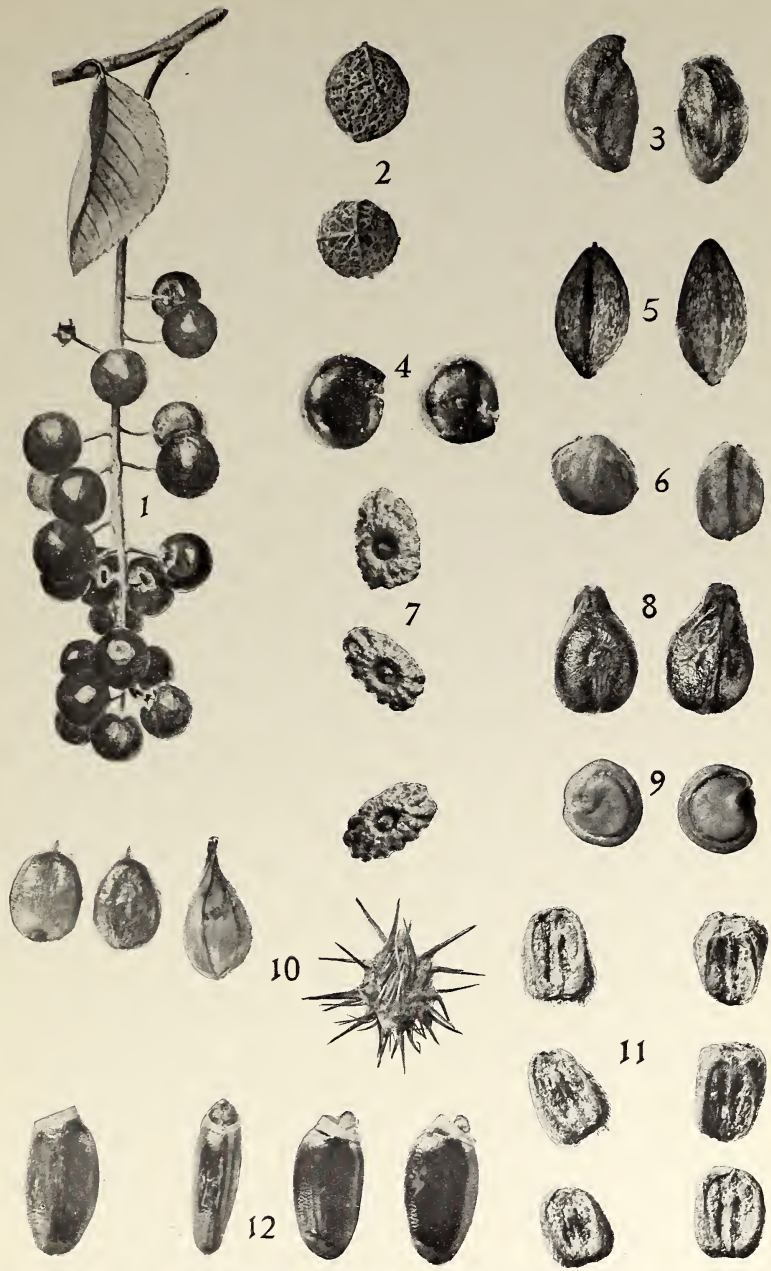
Cherries also are on the redbird's bill of fare. One correspondent states that redbirds filch cultivated varieties, but as none appeared in any of the stomachs examined, the occurrence probably is exceptional. Chokecherries are consumed, however, and Dr. A. K. Fisher has observed a cardinal eating the fruit of a seedling cherry (*Prunus avium*).

Wilson says cardinals feed upon the seeds of apples, but this habit also must be rare; in the course of the present investigation no cultivated fruit of any kind was found.

Six cardinals devoured blueberries (*Vaccinium* spp. including *V. virgatum*), three ate the aromatic berries of spice bush (*Lindera benzoin*), and 6 took the purple fruit of the pokeberry (*Phytolacca decandra*, Pl. II, fig. 4). The seeds of the succulent fruit of the prickly pear (*Opuntia opuntia*, Pl. II, fig. 9) were found in the stomachs of 3 cardinals, taken near the District of Columbia, where the plant abounds on the rocky banks of the upper Potomac. Six redbirds fed upon the drupes of sumac, including those of the poison ivy (*Rhus radicans*) and of the skunk bush (*Rhus trilobata*). These fruits are sometimes eagerly sought. The writer once in winter observed a scattering flock of 50 or more redbirds feeding on the berries of scarlet sumac.

The elderberry, which is so relished by the rose-breasted grosbeak, is rather neglected by the cardinal, only 2 having selected it. Two also ate ground cherries and black haws, while but 1 stomach contained rose hips, though the bird has often been observed devouring these fruits. Juneberries (*Amelanchier canadensis*, Pl. II, fig. 3) and others of the same genus are eaten; both holly (*Ilex opaca*) and inkberry (*I. glabra*) are occasionally secured, as well as red cedar berries (*Juniperus virginiana*), the fruit of the knockaway tree (*Ehretia elliptica*), and red haws (*Cratægus* sp.). In a stomach collected in South Carolina in January were more than 12 seeds of the berry of the passion flower (*Passiflora incarnata*). To the above list of fruits eaten by the cardinal, various authors add the wahoo berry (*Euonymus* sp.), Mexican mulberry (*Callicarpa americana*), and drupes of the cabbage palmetto (*Sabal palmetto*) and saw palmetto (*Serenoa serrulata*).

Among many items of vegetable food to be classed as miscellaneous are some of particular interest. Acorns were eaten by a few cardinals and one bird even selected a hickory nut. The strength of bill necessary to shear into such hard seeds may be imagined, and it



SEEDS AND FRUITS EATEN BY GROSBEAKS.

[1, Wild black cherry (*Prunus serotina*). 2, Hackberry (*Celtis occidentalis*). 3, Juneberry (*Amelanchier canadensis*). 4, Pokeberry (*Phytolacca decandra*). 5, Flowering dogwood (*Cornus florida*). 6, Rough-leaved dogwood (*Cornus asperifolia*). 7, Spiderwort (*Tradescantia virginiana*). 8, Summer grape (*Vitis æstivalis*). 9, Indian fig (*Opuntia opuntia*). 10, Bur grass (*Cenchrus tribuloides*). 11, Button weed (*Diodia teres*). 12, Milk thistle (*Mariana mariniana*). 1, Natural size; 2, 5, 9, 10 (bur), magnified twice; 6, 7, 8, 11, 12, magnified three times; 3, 4, 10 (seeds), magnified four times.]

is noteworthy that the cardinal appears to be the only one of the grosbeaks which uses its massive beak for the purpose for which it seems especially designed, namely, the cracking and grinding of hard seeds. The samaras of maple were found in a few stomachs, and in Florida Mr. C. J. Maynard [a] observed more than 20 cardinals feeding on the seeds of a single maple. The somewhat similar winged seeds of the tulip tree also serve as food, and, according to the experience of the writer, are a favorite winter diet of the redbird around Washington. Galls were eaten by 4 birds, and buds, which often have been stated to be especially sought after by grosbeaks, by only 2.

WEEDS.

The seeds of bindweeds, grasses, sedges, etc., form 36.38 percent of the entire food—more than half of the vegetable diet of the species. They were eaten by 361 of the birds examined, and range from 6 to 49 percent of the fare in different months, the greatest quantity being consumed in winter. The seeds of the various smartweeds (fig. 1) and bindweeds (fig. 21) are of most importance, having been consumed by 81 cardinals and constituting 5.57 percent of the annual food. Six species were identified, and it is probable that the seeds of all members of this large genus are eaten indiscriminately. They are among the commonest and worst weeds of both dooryards and cultivated fields. Besides being notorious crop chokers and seed adulterants, smartweeds are the main support of the disastrous corn-root aphids before the latter are transferred to the corn by their ant guardians. Hence the cardinal's habit of devouring smartweed seeds is beneficial, not only in abating direct injury by these pernicious weeds but also in tending to diminish the number of aphids by destroying their most important host plants.

Fig. 1.—Seeds of smartweed (*Polygonum lapathifolium*), (From Hillman, Nevada Experiment Station.)

The seeds of foxtail grasses (figs. 17 and 37) are next in importance. Foxtail is only too well known for its keen competition with cultivated crops, and is to be classed among the most troublesome weeds. Its seeds compose 3.21 percent of the cardinal's food, 51 out of 498 birds examined having eaten them. Bur grass (*Cenchrus tribuloides*, Pl. II, fig. 10) should be mentioned here, as it is possible some of its seeds were wrongly classed with those of foxtail, the shelled kernels of which they greatly resemble. They have been positively identified in several stomachs. Henry Nehrling [b] says cardinals "are very fond of bur grass seeds or sand spurs * * *

[a] Birds of E. N. A., 1881, p. 109.

[b] Our Native Birds of Song and Beauty, II, 1896, p. 196.

which are furnished with formidable spines. This grass is a very vile weed of the southern fields and the orange groves of Florida."

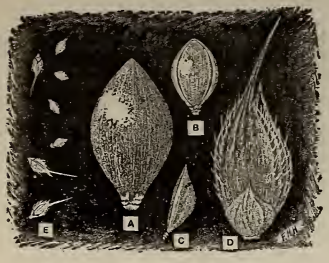


FIG. 2.—Seeds of cockspur grass (*Echinochloa crus-galli*). (From Hillman, Nevada Experiment Station.)

The seeds of other grasses, including cockspur grass (*Echinochloa crus-galli*, fig. 2), crab grass (*Syntherisma sanguinalis*), and allied species, which are well-known weeds, were fed upon by 31 redbirds, yard grass (*Eleusine indica*) by 31, and unidentified grasses by 22.

Seeds of the nearly related sedges (*Carex* et al.) were devoured by 41 cardinals, those of vervians (*Verbena hastata*, fig. 3, and *V. urticæfolia*) by 25. Twenty-two birds ate seeds of the well-known ragweeds (fig. 6), and 39 those of various spurges.

Among the other weed seeds eaten in smaller quantities are those of dodder, a serious pest in grain crops; vetch, dock, sow thistle, plantains, including the detestable ribgrass (fig. 4); tumbleweed (fig. 18), sunflower, violets, geraniums, stargrass, spiny sida, corn gromwell (fig. 5), spiderwort (Pl. II, fig. 7), lamb's-quarters, chickweed, stick-tight, sorrel, button weed (Pl. II, fig. 11), and stick-seed. To this list W. D. Doan adds clover and partridge pea.[a] One plant in the above list, namely, buttonweed, is known also as alligator head in the South, where it is a bad weed in rice fields. It has been said that "as the seeds are about the color of the soil they are not easily seen and are not apt to be picked up by birds." This is a mistake, however, for these seeds are devoured by many kinds of birds, and some, as the bobwhite, eat large numbers of them.

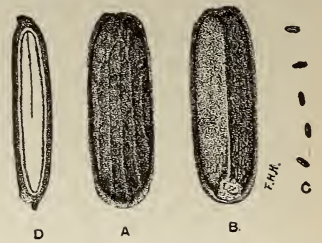


FIG. 3.—Seeds of blue vervain (*Verbena hastata*). (From Hillman, Nevada Experiment Station.)

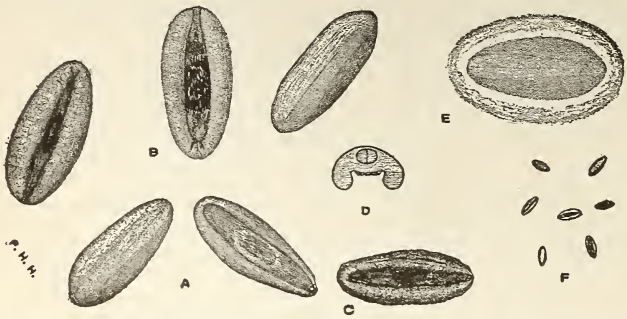


FIG. 4.—Seeds of ribgrass (*Plantago lanceolata*). (From Hillman, Nevada Experiment Station.)

After plants have seeded it is impossible for man appreciably to diminish the number of seeds. But this work is the peculiar function of

[a] Bull. 3, Agr. Exp. Sta., W. Va., 1888, p. 74.

seed-eating birds, and their great value to the farmer consists in the service they render in this direction. The warfare against seeds, so costly to him, is waged by the whole body of sparrows and other seed-eating birds year in and year out without cessation. Were it not for them the number of weeds would be vastly greater and the resulting damage correspondingly larger. How great this damage is will appear from the statement that the loss to the wheat interests of Minnesota from dockage, largely due to the presence of weed seed, is about $2,500,000 annually.[a] Moreover, conditions in Minnesota are not exceptional, and in every State the total annual loss from weed seeds is very great. So far, then, as farmers can protect and increase the number of weed-seed eating birds to that extent will they reap the benefit of increased service from these faithful servants. The redbird eats the seeds of many of the most harmful weeds, making more than a third of its subsistence upon them. Hence it occupies a very important place among the weed-destroying birds, and should be prized accordingly.

FIG. 5.—Seeds of corn gromwell (*Lithospermum arvense*). (From Hillman, Nevada Experiment Station.)

ANIMAL FOOD.

Though in quantity much less than the vegetable food, the animal portion of the cardinal's diet is much more diverse and is comprised in no less than six of the natural classes. These are myriapods, centipedes, insects, spiders, bivalves, and univalves. Insects are vastly more important than the others and constitute 26.25 out of 28.99 percent, the total proportion of animal matter consumed. The percentage is apportioned among the orders of insects as follows: Wasps 0.92, bugs 3.72, butterflies (and caterpillars) 5.1, grasshoppers 6.42, and beetles 10.48.

FIG. 6.—Seeds of ragweed (*Ambrosia artemisiaefolia*). (From Hillman, Nevada Experiment Station.)

[a] Bull. 95, Minn. Agr. Exp. Sta., 1906, p. 195.

The last-named group includes two mainly beneficial families, the ground beetles (Carabidæ) and the fireflies (Lampyridæ). Since the destruction of these beetles by the cardinal tends to neutralize the good done in other ways, it is important to understand thoroughly the nature of the bird's relation to them. Among the most beneficial of beetles are the caterpillar hunters (*Calosoma*, fig. 7), which ascend trees in quest of their prey, a rare habit among ground beetles. Thus these beetles attack caterpillars in a way others are unable to do. Two cardinals ate beetles of this genus. Another large carabid (*Pasimachus*), an enemy of grasshoppers and the army worm, was eaten by one redbird. Others devoured include *Harpalus caliginosus*, which is the bulky black beetle often seen feeding on the flowers of ragweed and which is evidently not entirely predaceous, and a larva of the nearly related beetle *Dicaelus*. Three birds captured individuals of the medium-sized but very hard *Scarites subterraneus*, which generally hides under stones by day. Specimens of two species of *Anisodactylus* and one beautiful blue *Callida* also were eaten. In all 34 redbirds fed upon beetles of this useful family, but each must have eaten sparingly, for the beetles compose but 0.75 percent of the entire food, an amount too small to be reckoned against the consumer of more than 8 times that quantity of grasshoppers, in addition to many other injurious insects.

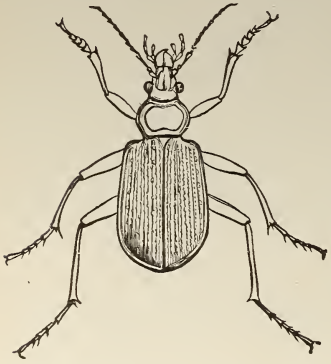


Fig. 7—Caterpillar hunter (*Calosoma scrutator*). (From Riley.)

Fireflies were eaten by only 4 cardinals, one of the birds obtaining the common black and yellow soldier beetle (*Chauliognathus marginatus*), which commonly feeds on the pollen of midsummer blossoms, and another, one of the small black fireflies (*Telephorus pusillus*), the larvæ of which are enemies of some common agricultural pests. Fireflies are eaten in such moderate measure that it is impracticable to assign them a percent, and we may conclude, so far as the present data go, that the cardinal does no appreciable injury to this group of insects.

The wasps and similar insects (Hymenoptera) include among their number many beneficial parasitic species, and for that reason their status as food of the redbird must be looked into. Fifty-nine of the grosbeaks examined had eaten these insects, but they amount to only 0.92 percent of the total food. None were positively identified as parasitic species, while some injurious forms were distinguished. Eleven cardinals ate ants, including the harvesting ants (*Pogonomyrmex*) and the small reddish *Lasius*, which foster plant lice, notably the corn root aphids. One grosbeak ate a sawfly, which also is an insect of unsavory reputation.

The cardinal is frequently alluded to in ornithological literature as preying upon bees. Peter Kalm published the first of these statements in 1770, and the later ones were probably suggested by, if not copied from, his. Wilson (1831), Nuttall (1832), and later authors reiterate the charge, though the context does not show that any of them knew of the matter at first hand. It is quite possible that, so far as this particular trait is concerned, the cardinal has been confounded with the similarly colored but otherwise very different summer redbird, which is well known to prey upon bees. At any rate, it is significant that the present examination did not reveal a single bee among the insect food of the redbirds. On the whole, the cardinal shows no great relish for Hymenoptera, and among the species eaten those injurious to man and the less valuable kinds predominate.

Among other possibly beneficial insects, the redbirds had eaten an assassin bug and a remarkable predaceous neuropteron (*Mantispa brunnea*), also a nymphal and an adult dragon fly. The latter creatures probably do as much harm in destroying young fish as good in preying upon insects. At most, not more than 2 percent, probably much less, of the cardinal's food consists of useful insects, while 12 times as much consists of injurious species, the destruction of which is a benefit.

One of the most important constituents of the major proportion is Lepidoptera. They compose 5.08 percent of the annual subsistence, amounting, however, in May to 26.71 percent. The adults taken consist of 5 moths and 1 butterfly, which together make up 0.17 percent of the food. Caterpillars are much more relished and 137 redbirds fed upon them, sometimes obtaining from 7 to 18 each. The cotton worm (*Alabama argillacea*, fig. 20), which formerly was a serious pest and which even now spoils a late-planted crop, was eaten by 3 cardinals. There is evidence that the bird habitually feeds upon this insect, and as early as 1885 C. V. Riley remarked[a] that "birds are of incalculable benefit" in combating the cotton worm, and the cardinal is one of those which prey upon it more or less persistently.

A second cotton pest, the bollworm (*Heliothis obsoleta*, fig. 8), which is familiar also as the corn ear-worm, is occasionally devoured, and a third, the cotton cutworm (*Prodenia ornithogalli*, fig. 9) is greatly relished. Ninety-six of the latter were eaten by 31 cardinals from the Texas cotton fields. The destruction of cotton insects by the redbird is important, since the bird is numerous in the cotton region and feeds upon the worst enemies of the plant.

The sphinx caterpillars, so many of which are injurious to cultivated plants, were eaten by 20 redbirds. The species identified are the laurel sphinx (*Sphinx kalmiæ*) and the purslane sphinx (*Deilephila lineata*, fig. 38), the latter being a general feeder and attacking

[a] Fourth Ann. Rep. U. S. Ent. Comm. 1885, p. 88.

several garden and field crops. Measuring worms were eaten by 2 cardinals, the zebra caterpillar (fig. 10) of the cabbage by 1, while 2 secured chrysalides of the notorious codling moth. It thus appears that the lepidopterous food of this grosbeak contains a number of serious pests, and the bird accomplishes much good by destroying them.

FIG. 8.—Bollworm or corn-ear worm (*Heliothis obsoleta*). (From Quaintance, Bureau of Entomology.)

A somewhat larger number of cardinals than ate caterpillars preyed upon grasshoppers, and these insects form a correspondingly larger proportion of the food, namely 6.43 percent. Crickets and long and short horned locusts were eaten and a decided taste for the eggs of katydids is shown, they being consumed by 21 redbirds. Among the short-horned grasshoppers the small shield-back grouse locusts were taken, and also the lesser migratory locusts (*Melanoplus atlanis*, fig. 39), which during the invasions of the Rocky Mountain grasshopper was second only in importance to that formidable insect. The cardinal did its share in repelling the locust hosts in the seventies, Mr. Aughey, of Nebraska, finding more than 20 locusts per bird during his examinations. It is certain that the redbird's aid in restricting the less conspicuous pests of the present day is no less valuable.

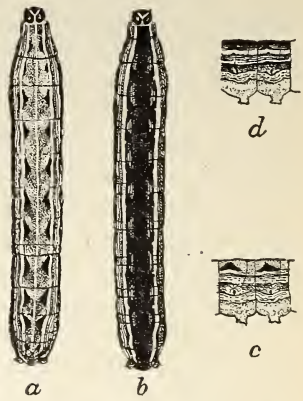


FIG. 9.—Cotton cutworm (*Prodenia ornithogalli*). (From Chittenden, Bureau of Entomology.)

Other insects bearing the name "locusts," but not at all closely

related to the grasshoppers, belong to the order Hemiptera, which furnishes 3.72 percent of the cardinal's subsistence. These dogday locusts, harvest or jarflies, which injure the twigs of trees, are, on account of their loud, vibrating song, among the best-known insects.

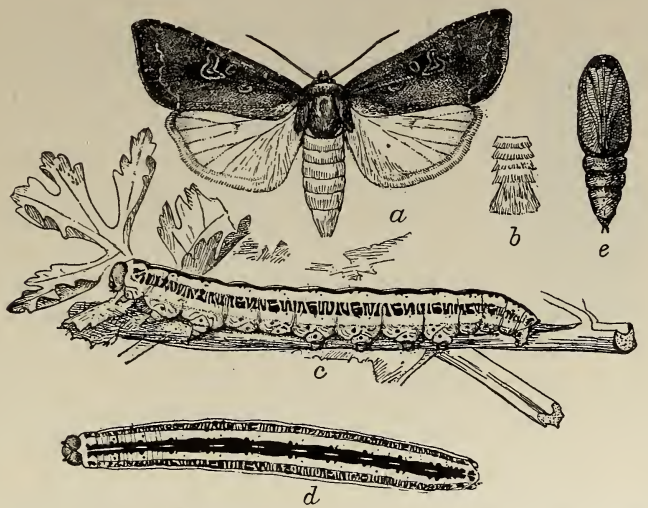


FIG. 10.—Zebra caterpillar (*Mamestra picta*). (From Chittenden, Bureau of Entomology.)

Their great size would seem to prevent most birds from capturing them, but 9 of the redbirds examined had accomplished the feat. The common harvest fly (*Cicada tibicen*, fig. 11) was identified from

FIG. 11.—Harvest fly (*Cicada tibicen*). (From Lugger, Minnesota Experiment Station.)

two stomachs, and according to A. W. Butler[a] the seventeen-year locust (*Tibicen septendecim*) also is eaten by the redbird.

Several insects of this order are miniatures of the cicadas, such as the jumping plant-lice (Psyllidæ) and leaf-hoppers (Tettigonidæ).

[a] Bull. 12, Div. Ent., 1886, p. 30.

These and the curiously shaped tree-hoppers (Membracidæ), all of which are more or less injurious, are occasionally taken by the redbird. More often this grosbeak secures the tiny bark-lice or scale insects (Coccidæ). These minute but nevertheless destructive pests, which have not long been known to be preyed upon to any extent by birds, were devoured by 21 cardinals. The cherry scale (*Eulecanium cerasifex*), which is sometimes injurious, was identified from one stomach, while another contained scales which are probably the locust bark-scale (*E. robiniarum*). Other scale insects of the same genus were fed upon by 15 cardinals and those of a related genus (*Toumeyella*) of the southeastern United States by 2.

Other Hemiptera were eaten by 59 grosbeaks, 31 selecting the vile-smelling stinkbugs (Pentatomidæ), including the green tree-bug (*Nezara hilaris*) and 1 specimen of *Euschistus*. The secretions of the latter insect have proved fatal to such hardy creatures even as weevils, but apparently they do not daunt the cardinal. One assassin bug and 1 species of the chinch-bug family also were devoured. Practically all of the Hemiptera eaten are injurious, and some, such as the scale insects, extremely so. Consequently, the cardinal's habit of preying upon them is highly beneficial.

Passing to beetles, we find weevils are eaten to a greater extent than any others. These compactly formed snout-bearers belong to 10 families, members of 3 of which are preyed upon by the cardinal. Most of the weevils attack nuts, fruits, and seeds, including those of cultivated plants. Hence, they are generally harmful and many kinds are exceptionally destructive. Weevils often are obscurely colored and have the habit of feigning death, but notwithstanding these protective devices they are captured in large numbers by all insectivorous birds. One hundred and fifty-seven cardinals ate weevils in quantity sufficient to make 3.26 percent of the food of all examined. Scarred snout-beetles and curculios are equally relished. Sixteen redbirds fed upon a species (*Compsus auricephalus*) of the former group, which, in the adult state, occurs upon the leaves of cotton. The tiniest fragment of this insect suffices for identification, because of the beautiful covering of silvery green and golden scales. Thirteen other grosbeaks ate scarred snout-beetles which can not be identified. Of curculios, the acorn weevil (*Balaninus nasicus*), with a snout almost as long as the body, and several species of 5 weed-mining genera were captured. Six redbirds ate the injurious clover weevils (*Sitones*). The cotton boll weevil (fig. 19) also is occasionally eaten by the cardinal, 2 of the present collection having secured specimens of this highly destructive insect. Twelve redbirds captured curculios which were not further determined. Bill-bugs (fig. 12), which as larvæ live in the roots of grasses or sedges and as adults often injure corn by drilling holes in the stems of young plants, were de-

voured by 13 cardinals. Two species (*Sphenophorus cariosus* and *S. compressirostris*) were identified.

Lamellicorn or scarabæid beetles are next in importance to weevils in the beetle diet of the cardinal. They were eaten by 77 birds and compose 2.56 percent of the annual food. Many of them feed on excrementitious matter and are of neutral economic significance: but few of these are consumed by the bird. Those secured include the common road-frequenting dung beetles, which were captured by 6 cardinals, and the large resplendant scavenger *Phanæus carnifex*.

FIG. 12.—A bill bug (*Sphenophorus*). (From Forbes, Illinois Experiment Station.)

Other species in this family, however, are not so harmless as the above. The spotted vine-chafer (*Pelidnota punctata*), which is an important grape pest in the eastern United States, the two-spotted *Anomala*, which also devours the foliage of the grape, and the cetonias (*Euphoria inda*, fig. 15; *E. fulgida*, et al.), which feed upon all sorts of flowers and sometimes on young Indian corn, are all accepted as food by the cardinal. The southern june beetle or figeater (*Allorhina nitida*, fig. 13), which causes considerable damage in Florida and neighboring States, was found in a few stomachs: but since the cardinal evinces a strong preference for large insects and abounds in this beetle's favorite home, many of them, no doubt, are devoured. Of greatest interest in this family are the rose-chafers (*Macrodactylus subspinosis*, fig. 14.) These beetles are so abundant at times, says Prof. J. B. Smith, that they "ruin not only vineyards, but orchards and gardens, eating every kind of fruit and flower;

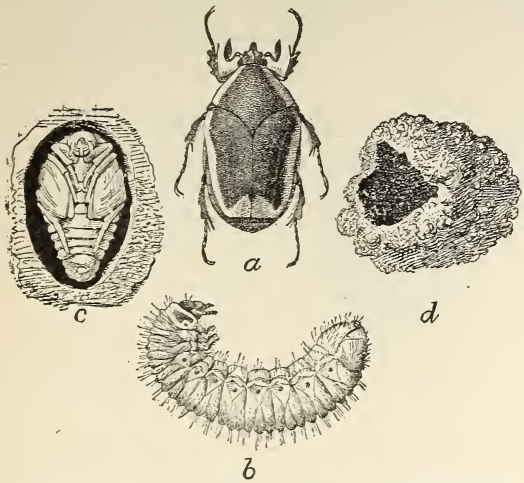


FIG. 13.—Figeater (*Allorhina nitida*). (From Howard, Bureau of Entomology.)

two or three days suffice to ruin a vineyard." These insects have very long and spiny legs, and opinions differ as to whether birds eat them, some affirming that they do, others that they do not. As a matter of fact, they are preyed upon by several wild birds, including the yellow-billed cuckoo, crow blackbird, kingbird, phoebe, green-

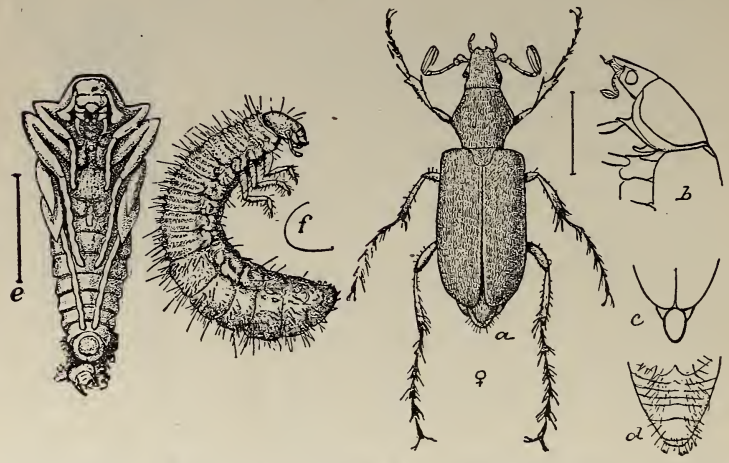


FIG. 14.—Rose beetle (*Macrodactylus subspinosus*). (From Riley, Bureau of Entomology.)

crested flycatcher, redheaded woodpecker, and cardinal, the last-named being one of the most important of their enemies. Four of the birds examined during the present investigation had eaten rose-beetles, each of them taking several, and on July 5, 1906, the writer watched a brood of young which were being fed rose-chafers, remains

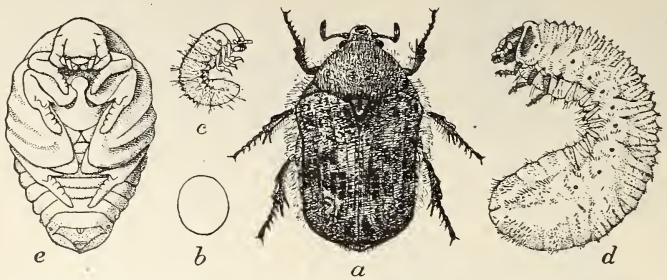


FIG. 15.—Flower eating scarabæid (*Euphoria inda*). (From Chittenden, Bureau of Entomology.)

of 17 being recovered from ejecta. These facts indicate that the cardinal is so fond of the rose-beetle as to capture it whenever possible. This habit of the bird, together with its inroads upon the vine-chafers of the family, are of considerable economic importance.

Next in importance among beetles in the diet of the cardinal grosbeak are the bronzy wood-borers (Buprestidæ), which compose

1.17 per cent of the subsistence, being eaten by 31 birds. In the larval state these beetles excavate tunnels in trees and do immense damage. Two species were identified in stomachs of the redbird, namely, the locust borer (*Agrilus egenus*) and another (*Dicerca obscura*) which bores into various deciduous trees. The beetles of this family seem to be a regular item of diet of all kinds of grosbeaks, and we may be sure that their destruction is highly beneficial.

The rather similar appearing click-beetles, adults of the disastrous wireworms, were secured by 23 redbirds. Twelve birds ate long-horned borers (Cerambycidæ), 2 species being identified, neither of which is an important pest. However, the entire family is injurious, and the cardinal should be commended for diminishing the numbers of any of the species.

The closely related family of leaf-beetles (Chrysomelidæ) does not furnish a large percentage of the redbird's fare, although several of its species are captured. The notorious spotted cucumber-beetle (*Diabrotica 12-punctata*, fig. 26), the strawberry root-borer (*Colaspis brunnea*), plum leaf-beetle (*Nodonota tristis*), sweet potato leaf-beetle (*Coptocycla*), willow and poplar species (*Chrysomela bigsbyana* and *Melasoma scripta*), besides some others that feed on weeds and other wild plants, are occasionally eaten. Two additional species, the locust leaf-miner and the three-lined potato beetle, deserve more extended notice. Concerning the locust leaf-mining beetle (*Odontota dorsalis*, fig. 16), Dr. S. D. Judd says, in "Birds of a Maryland Farm:"[a]

FIG. 16.—Locust leaf-miner (*Odontota dorsalis*). (From Chittenden, Bureau of Entomology.)

> In the summer of 1895 a destructive outbreak * * * turned all the locusts of the farm as brown as if they had been scorched by fire, ruining the verdure of the river bluff. * * * From 1896 to 1902, inclusive, the beetles did not again ruin the foliage. * * * In 1896 the trees further up the river, however, were turned brown, showing that the escape of those at Marshall Hall was not due to climatic conditions unfavorable to the insects; therefore it is possible that the birds were at least to some extent responsible for it.

[a] Bull. 17, Biological Survey, 1902, pp. 29–30.

The cardinal is one of the birds which assisted in checking this infestation. Two individuals taken at the time had eaten leaf-miners, one having secured no fewer than 10.

Before the advent of the Colorado beetle, a smaller leaf-beetle (*Lema trilineata*), which naturally feeds on ground cherries (*Physalis*), turned its attention to potatoes and made itself widely known. Even at present it is by no means harmless in the Southern States. It is encouraging, therefore, to know that the cardinal seems to relish the species, one bird collected in Florida having eaten 14 of them. The cardinal has been reported to feed upon the genuine potato beetle also, by E. B. Williamson[a] and F. H. Chittenden.[b] Thus while not preying extensively upon the Chrysomelidæ, the redbird at times renders valuable service by eating some of the pests so numerous in the family.

The cardinal occasionally captures a few other kinds of beetles, such as the darkling beetles (Tenebrionidæ) noted for their nauseous secretions, and the blister beetles (Meloidæ), the fluids of whose bodies are highly vesicatory.

But few additional insects are consumed. One cardinal had eaten a two-winged fly, a member of an order the individuals of which are perhaps more abundant than those of any other, yet which is surprisingly exempt from the attacks of birds. Three redbirds devoured fragile mayflies of the kinds that often swarm about the lights of cities. They sometimes eat the larger kinds also, as was observed by Dr. A. K. Fisher, July 4, 1906, when a male cardinal was seen carrying in its beak one of the large dark mayflies (*Hexagenia bilineata*).

Belonging, together with the insects, to the subkingdom of the jointed animals (Arthropoda) are the spiders and centipedes, which in a small way contribute to the fare of the cardinal. One bird had eaten a centipede, while 22 obtained spiders or their egg sacs.

Snails and other mollusks were eaten by a great many of the birds examined, namely 112. Whether they were taken for grinding material or for food is a question, but the latter seems more likely in view of the large number devoured. One grosbeak had eaten several small bivalve shells which must have been obtained from water, and another secured a large slug.

The following note by D. E. Lantz shows that occasionally vertebrates serve as food.[c]

> December 27 [1884], while hunting, I saw a male cardinal grosbeak eating a field-mouse. Several others attempted to take it from him, but were unsuccessful. At my approach they left it lying on the snow. It was about half consumed.

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[a] Proc. Columbus Hort. Soc., XIII, 1898, p. 42.

[b] Circular 87, Bureau of Entomology, 1907, p. 12.

[c] O and O., X, 1885, p. 29.

Mineral Matter.

Mineral matter taken for grinding purposes, among which were many bits of cinder in addition to the usual quartz fragments and sand, averaged 5.7 percent of the gross contents of the stomachs examined.

Nestlings.

The nestlings of the cardinal, in common with those of most birds, are highly insectivorous. During the preparation of this report 4 have been examined, with the result that 94.75 percent of their food was found to be animal matter and 5.25 vegetable. Two of the number were young, just out of the nest, and they had consumed the vegetable substances; 2 were nestlings, and their diet was entirely animal. The stomach of one of the latter contained the thorax of a large cicada, and that of the other the remaining portions of that luckless insect. Both had been fed caterpillars—purslane (fig. 38) and laurel sphinxes—and each contained grasshoppers and spiders. A few larvæ and eggs of other insects also were in their stomachs. One of the young, just out of the nest, had been given a cicada, and, in addition, some 9 grasshoppers, a snail, and a few seeds, while the other had eaten lamellicorn beetles, weevils, and blackberry seeds. The proportions of the principal food items of the four nestlings are as follows: Cicadas, 17.25 percent; grasshoppers, 20; caterpillars, 21.25; and beetles, 23.25. Two other fledgelings in the collection had only a few bits of snail in their stomachs.

Observations upon nestling birds in the field being recognized as valuable in supplementing data obtained from the examination of stomachs, an effort was made throughout the season of 1906 to locate and thoroughly study a grosbeak family. Owing to various vicissitudes, satisfactory observations were made upon only one nest. Fifty-six trips by the parents were made to this nest in six and one-half hours, an average of 8.6 an hour. The young were fed 178 times, an average of 89 each. The longest interval between visits was thirty-five minutes, the shortest two.

The character of the food could not be determined by observation, but it was learned in another way. None of the excrement was removed from the box, whereas the nest in which the youngsters had been reared was kept perfectly clean. The fecal matter was dried and examined, and while by no means all of its constituents could be identified, enough was learned to indicate that the study of excreta is a very satisfactory method of determining the food of nestling birds. The nest of any fairly bold bird may be kept under surveillance and the waste matter collected before the parents remove it. The extent of the information as to the food eaten by the young to be obtained in this way is astonishing.

For instance, a single casting of a young cardinal, covered with its thick, chalky, and gelatinous layers, was preserved, and from it were taken the following: One insect egg, the leg and scutellum of a scarabæid beetle, head and other remains of a leaf-hopper, bits of a snail, and 11 seeds and the core of a mulberry. From the remainder of the total quantity the following were identified: Seventeen rose-beetles (*Macrodactylus subspinosus*, fig. 14), 2 other scarabæids, 1 click beetle (*Limonius* sp.), 1 caterpillar hunter (*Calosoma scrutator*, fig. 7), 1 leaf-hopper (Jassidæ), 3 grasshoppers, 1 spider, 1 dragon fly, many bits of snail, 17 blackberry seeds (*Rubus* sp.), and 221 seeds of mulberry (*Morus rubra*). The only beneficial species in the above list is the caterpillar hunter, while among the injurious forms, four in number, the rose-beetle is very important. This insect's habits, as well as its occasional overwhelming abundance, have been described on a preceding page.

The infestation of the insect about the District of Columbia in 1906 was especially severe. Not only roses were attacked by the insects, but elder blossoms were covered, and around the basswoods their humming was as loud as of a swarm of bees. Frequent attempts were made to discover whether the cardinal feeds upon them, but no opportunity was afforded until the above-mentioned nestlings were discovered at the extreme end of the rose-beetle season. The fact that so many were taken at that time is good evidence that special search was made for them.

Among the food given to the inmates of a nest under observation in 1907, the following were identified by sight: A chrysalis, a caterpillar or sawfly larvæ, a horsefly, and a grasshopper. From a small quantity of excrement were recovered bits of snail, grass seed, a small caterpillar, ground and click beetles, and 3 rose-beetles. The capture of the latter is again significant, as they were very scarce up to that time. This fondness for rose-beetles distinguishes the bird as an important guardian of the plants the insects attacks.

Summary.

Examination of nearly 500 stomachs of cardinals shows that the bird's diet is about three-tenths animal and seven-tenths vegetable.

The cardinal has been accused of pilfering certain grains, notably corn, to an injurious extent, which charge the evidence from stomach examination neither proves nor disproves. But in view of the fact that only 8.73 percent of the total food is grain, and that more than half of that amount is waste, the loss is greatly overbalanced by the destruction of weed seeds alone, which compose more than half of the vegetable food. Moreover, some of the weeds consumed are especially destructive to grain crops.

In securing its insect food the cardinal injures us in 1 case and benefits us in 15. In other words, considering the animal food alone,

only 1 cardinal does harm to 15 which do good. The presence of this single harmful bird among so many beneficial ones no more justifies us in classing the species as injurious than would a like proportion of disabled men justify the condemnation of a whole regiment.

On the contrary, since the cardinal, by its general food habits, does at least 15 times more good than harm, it must be classed among the very useful species. The following list of important pests the bird has been shown to prey upon is in itself sufficient proof of the cardinal's value. The list includes the Rocky Mountain locust, 17-year cicada, potato beetle, cotton worm, bollworm, cotton cutworm, cotton-boll weevil, codling moth, rose-beetle, cucumber-beetle, fig-eater, zebra caterpillar, plum scale, and other scale insects. A host of minor insect pests are attacked and the seeds of many noxious weeds are destroyed. The cardinal much more than pays its way, and deserves and should receive strictest protection. The bird is easily attracted by food in winter and by the provision of suitable nesting sites in summer. Being thus responsive to human care, and being so valuable economically, the cardinal's presence on the farm, and even in the city garden, should be encouraged in every possible way. With proper protection and encouragement it will become more and more numerous and render husbandry a correspondingly increased amount of useful service.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE CARDINAL.

GRAIN.

Corn (*Zea mays*).
Rice (*Oryza sativa*).
Kafir corn (*Sorghum vulgare durra*).
Oats (*Avena sativa.*)
Wheat (*Triticum vulgare*).

WILD FRUITS.

Red cedar (*Juniperus virginiana*).
Solomon's seal (*Pologonatum biflorum*).
Bristly greenbrier (*Smilax bona-nox*).
Hickory (*Hicoria* sp.).
Oak (*Quercus* sp.).
Southern hackberry (*Celtis mississippiensis*).
Hackberry (*Celtis occidentalis*).
Mulberry (*Morus* sp.).
Pokeberry (*Phytolacca decandra*).
Tulip tree (*Liriodendron tulipifera*).
Spicebush (*Lindera benzoin*).
Blackberry (*Rubus* sp.).
Rose (*Rosa* sp.).
Juneberry (*Amelanchier canadensis*).
Red haw (*Crataegus* sp.).
Cherry (*Prunus* sp.).
Skunk bush (*Rhus trilobata*).
Poison ivy (*Rhus radicans*).
Holly (*Ilex opaca*).
Inkberry (*Ilex glabra*).
Maple (*Acer* sp.).
Summer grape (*Vitis aestivalis*).
Frost grape (*Vitis cordifolia*).
Bullace grape (*Vitis rotundifolia*).
Maypop (*Passiflora incarnata*).
Prickly pear (*Opuntia opuntia*).
Rough-leaved cornel (*Cornus asperifolia*).
Flowering dogwood (*Cornus florida*).
Blueberry (*Vaccinium virgatum*).
Knockaway tree (*Ehretia elliptica*).
Nightshade (*Solanum* sp.).
Elder (*Sambucus* sp.).
Arrowwood (*Viburnum* sp.).

WEEDS.

Large crab grass (*Syntherisma sanguinalis*).
Barnyard grass (*Echinochloa crus-galli*).
Yellow foxtail (*Chætochloa glauca*).
Bur grass (*Cenchrus tribuloides*).
Wire grass (*Eleusine indica*).
Sedge (*Carex* sp.).
Spiderwort (*Tradescantia* sp.).
Rush (*Juncus* sp.).
Star grass (*Hypoxis hirsuta*).
Star grass (*Hypoxis juncea*).
Dock (*Rumex* sp.).
Knotgrass (*Polygonum aviculare*).
Pale persicaria (*Polygonum lapathifolium*).
Pennsylvania persicaria (*Polygonum pennsylvanicum*).
Smartweed (*Polygonum punctatum*).
Virginia knotweed (*Polygonum virginianum*).
Hastate tearthumb (*Polygonum arifolium*).
Goosefoot (*Chenopodium* sp.).
Pigweed (*Amaranthus* sp.).
Chickweed (*Alsine media*).
Vetch (*Vicia* sp.).
Cranesbill (*Geranium* sp.).
Sorrel (*Oxalis* sp.).
Croton (*Croton* sp.).
Spurge (*Euphorbia* sp.).
Spiny sida (*Sida spinosa*).
Violet (*Viola* sp.).
Dodder (*Cuscuta* sp.).
Stickweed (*Lappula* sp.).
Gromwell (*Lithospermum arvense*).
White vervain (*Verbena urticaefolia*).
Blue vervain (*Verbena hastata*).
Rib grass (*Plantago lanceolata*).
Plantain (*Plantago* sp.).
Buttonweed (*Diodia teres*).
Prickly sow-thistle (*Sonchus asper*).
Ragweed (*Ambrosia artemisiaefolia*).
Sunflower (*Helianthus* sp.).
Sticktight (*Bidens* sp.).

COLEOPTERA.

Ground beetles (Carabidæ):
Calosoma scrutator.
Pasimachus sp.
Scarites subterraneus.
Dicaelus sp.
Callida sp.
Harpalus caliginosus.
Anisodactylus rusticus.
Anisodactylus agricola.
Click-beetles (Elateridæ):
Melanotus sp.
Bronzy wood-borers (Buprestidæ):
Dicerca obscura.
Agrilus egenus.
Fireflies (Lampyridæ):
Chauliognathus marginatus.
Telephorus pusillus.
Lamellicorn beetles (Scarabæidæ):
Phanæus carnifex.
Aphodius lividus.
Aphodius inquinatus.
Macrodactylus subspinosus.
Anomala binotata luteipennis.
Pelidnota punctata.
Allorhina nitida.
Euphoria fulgida.
Euphoria inda.
Long-horned beetles (Cerambycidæ):
Liopus adspersus.
Hippopsis lemniscata.
Leaf-beetles (Chrysomelidæ):
Donacia sp.
Lema trilineata.
Cryptocephalus calidus.
Colaspis brunnea.
Nodonota tristis.
Chrysomela sp.
Calligrapha bigsbyana.
Zygogramma hcterotheca.
Melasoma scripta.
Diabrotica 12-punctata.
Odontota dorsalis.
Coptocycla sp.
Darkling beetles (Tenebrionidæ):
Blapstinus pratensis.
Blister beetles (Meloidæ).
Scarred snout-beetles (Otiorhynchidæ):
Graphorhinus vadosus.
Compsus auricephalus.
True snout-beetles (Curculionidæ):
Sitones sp.
Pachytychius amœnus.
Anthonomus grandis.

COLEOPTERA—continued.

True snout-beetles—Continued.
Conotrachelus sp.
Tyloderma baridium.
Baris interstitialis.
Balaninus nasicus.
Billbugs (Calandridæ):
Rhodobaenus 13-punctatus.
Billbugs—Continued.
Sphenophorus cariosus.
Sphenophorus compressirostris.
Barkbeetles (Scolytidæ):
Tomcius impressus.

HEMIPTERA.

Cicadas (Cicadidæ):
Cicada tibicen.
Tree-hoppers (Membracidæ).
Leaf-hoppers (Tettigonidæ).
Jumping plant-lice (Psyllidæ).
Scale insects (Coccidæ):
Eulecanium cerasifex.
Eulecanium robiniarum (?).
Scale insects—Continued.
Toumeyella sp.
Stink-bugs (Pentatomidæ):
Euschistus sp.
Nezara hilaris.
Lygæidæ.
Assassin bugs (Reduviidæ).

ORTHOPTERA.

Short-horned grasshoppers (Acrididæ):
Melanoplus atlanis.
Tettix sp.
Long-horned grasshoppers (Locustidæ).
Crickets (Gryllidæ).

LEPIDOPTERA.

Hawk-moths (Sphingidæ):
Deilephila lineata.
Sphinx kalmiæ.
Owlet-moths (Noctuidæ):
Mamestra picta.
Prodenia ornithogalli.
Alabama argillacea.
Owlet moths—Continued.
Heliothis obsoleta.
Spanworms (Geometridæ):
Nadata gibbosa.
Leaf-rollers (Tortricidæ):
Carpocapsa pomonella.

HYMENOPTERA.

Rough-headed ants (Myrmicidæ):
Pogonomyrmex sp.
Smooth-headed ants (Formicidæ):
Lasius sp.
Sawflies (Tenthredinidæ).

OTHER INSECTS.

Dragon fly (Odonata).
Mantispa brunnea (Neuroptera).
Two-winged fly (Diptera).
Mayfly (Ephemerida).

OTHER INVERTEBRATES.

Spiders (Araneida).
Centipedes (Chilopoda).
Snails and slugs (Gastropoda).
Bivalves (Pelecypoda).

GRAY GROSBEAK.

(*Pyrrhuloxia sinuata.* Plate I, Frontispiece.)

APPEARANCE, DISTRIBUTION, AND HABITS.

This grosbeak, which so far has received no distinctive popular name, may be known as the gray grosbeak or parrot-bill. It is almost the same size as the cardinal, closely resembles that species in song and general demeanor, and has similar nesting habits. Moreover, it frequents the same kind of country and is resident wherever found. In appearance, however, it is quite dissimilar.

In strong contrast to the glowing hue of the cardinal, the general color of both sexes of the parrot-bill is light gray. The wings, tail, and long crest are suffused with dark red and the wings are lined with rose. This color also surrounds the beak of the male and extends over throat and breast in an irregular patch. The beak is yellowish and is very curiously modified, being short, thick, strongly curved, and apparently of great power.

The gray grosbeak occurs over about the lower third of Arizona and New Mexico and the lower half of Texas, not reaching, however, the extreme eastern part of the latter State. There are two subspecies, the Arizona parrot-bill (*P. sinuata*) and the Texas parrot-bill (*P. s. texana*). Their range extends south to central Mexico.

ECONOMIC RELATIONS.

Seventy-four stomachs of gray grosbeaks have been examined. All are from Texas, 59 being collected in August and 15 in September. They do not, therefore, give an adequate idea of the food habits of the species, except for that locality and season. Vegetable matter averages 71.19 percent of the contents, and animal matter 28.81 percent. Contrasting the latter amount with 36.54 percent of animal food obtained during a corresponding period by the cardinal, which is highly vegetarian, it appears exceedingly low. It is accounted for, however, by the extraordinary preference of the parrot-bill for a single item of its vegetable diet, namely, the seeds of grasses.

Vegetable Food.

Another remarkable feature of the vegetable diet is the scarcity of fruit. Only a few pokeberries were eaten, not enough in fact to be allotted a percentage valuation. Cardinals, however, collected in the same locality at the same time consumed almost 12 percent of fruit in August and nearly 30 percent in September. It appears, therefore, that the gray grosbeak is distinguished from its nearest relative by a remarkable indifference for fruit.

WEEDS.

Grass seeds constitute an average of 53.09 percent of the total food of the birds examined, or more than five-sevenths of the vegetable food alone. Most important among them are foxtail (*Chætocholoa*, fig. 17) and bur grass (*Cenchrus*, Plate II, fig. 10), which together amount to 43.59 percent of all the bird's food. Since these grasses are among the most pernicious weeds, the parrot-bill is more than welcome to all of their seeds it desires.

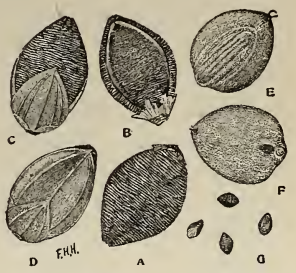

FIG. 17.—Seeds of yellow foxtail (*Chætochloa glauca*). (From Hillman, Nevada Experiment Station.)

The seeds of other grasses also are important, furnishing 9.51 percent of the bird's subsistence. Among them are seeds of witch and crab grasses, most species of which are weeds. Yard or wire grass (*Eleusine indica*) also is eaten. Seeds of a spurge (*Croton* sp.) contribute 9.81 percent to this grosbeak's fare, and other weeds, including bindweed (fig. 21), lambs' quarters, tumbleweed (fig. 18), sunflower, carpet weed, nightshade, vervain (fig. 3), mallow, etc., compose 6.13 percent.

Thus the gray grosbeak is a great consumer of weed seeds, and it is remarkable that seeds form practically seven-tenths of the food in August and September, when insects are superabundant. The bird's habit of feeding upon weeds is undoubtedly beneficial, especially because it eats so many seeds of foxtail and bur grass, pests with which every farmer in the South has to contend.

GRAIN.

The only grain found in stomachs of this species is sorghum. Six birds had eaten it in quantity sufficient to make an average of 2.03 percent of the total food. Ignoring even the fact that sorghum is

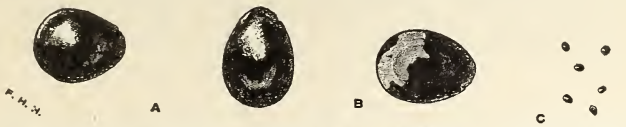

FIG. 18.—Seeds of rough tumbleweed (*Amaranthus retroflexus*). (From Hillman, Nevada Experiment Station.)

usually grown for fodder, not for grain, the amount consumed is so small that there need be no fear of damage by this shy and uncommon bird.

ANIMAL FOOD.

While the parrot-bill consumes a smaller proportion of animal matter than other grosbeaks, it selects about the same things, the principal items being grasshoppers, caterpillars, and beetles.

Neither parasitic Hymenoptera nor predaceous beetles were found in the stomachs examined, a showing much to the bird's credit. Only one useful insect had been eaten, it belonging to the queer neuropteroid genus *Mantispa*, the members of which are rare. They are predaceous when adult and when young are parasitic in the egg-sacs of spiders.

The remainder of the animal food is composed of injurious species, among which are important pests. Beetles constitute 4.66 percent of the food, weevils alone being 3.42. Of greatest interest among the latter is the cotton-boll weevil (*Anthonomus grandis*, fig. 19), the most serious agricultural pest of recent years. While the gray grosbeak does not feed upon it regularly, nevertheless the habit of picking it up when occasion offers is highly commendable. Among other weevils eaten are additional species of curculionids and scarred snout-beetles, including the same silvery-green and golden species (*Compsus auricephalus*) eaten by the cardinal.

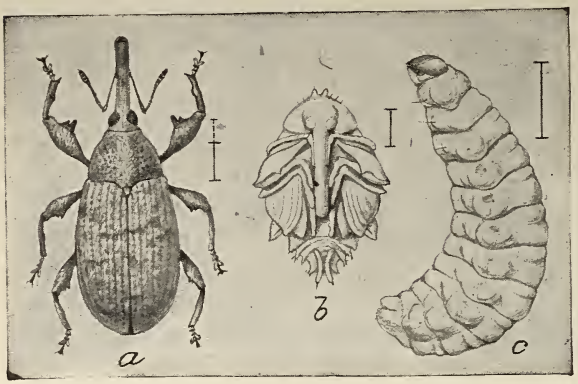

FIG. 19.—Cotton-boll weevil (*Anthonomus grandis*). (From Howard, Bureau of Entomology.)

Leaf beetles (Chrysomelidæ) probably are next in importance. The parrot-bill is sharp-eyed enough to find a species (*Chlamys plicata*) of this family that is noted for the perfection of its protective devices. This little beetle is curiously sculptured and has furrows in which all the appendages fold, and, being bronzy in color, its resemblance to the droppings of caterpillars is almost perfect. The *Chlamys* sometimes feeds upon raspberry leaves, but has never been found very injurious. Nevertheless, it is entirely vegetarian, like all the other beetles of the family, species of which, even if not at present positively injurious, are liable to become so at any time. The parrot-bill should receive nothing but praise for its destruction of leaf-beetles.

Bronzy wood-borers (Buprestidæ) and long-horned beetles (Cerambycidæ), both of which are destructive to forest and orchard trees, also were found in stomachs of this species.

Beetles, as a whole, are exceeded in amount by caterpillars, the latter constituting 10.32 percent of the diet. One of the species identified, namely, the cotton worm (*Alabama argillacea*, fig. 20), has long been known as a great pest throughout the Southern States.

and in certain years has caused a decrease in the crop of a quarter of a million bales, valued at $25,000,000. Many birds devour great numbers of cotton worms, and this fact alone justifies the oft-repeated statement that "too much can hardly be said in favor of insectivorous birds in cotton fields." The gray grosbeak assumes a proper share in this valuable work, 14 of the 74 individuals examined having consumed cotton worms, which formed an average of 39.1 percent of their food. As many as 18 caterpillars were found in a single stomach. Another caterpillar enemy of the same crop, the cotton cutworm (*Prodenia ornithogalli*, fig. 9), also is freely devoured.

As beetles were less esteemed than caterpillars by the gray grosbeak, so also are the latter less liked than the Orthoptera. This group contributes 11.52 percent of the total food. Both long and short-horned locusts and their eggs are devoured, 7 or 8 grasshoppers sometimes being secured by a single bird. The only species (*Syrbula admirabilis*) identified sometimes feeds on timothy.

True bugs, comprising stink-bugs (Pentatomidæ) and their eggs, cicadas, leaf-hoppers (Jassidæ), and lantern flies (Fulgoridæ) compose about 1.5 percent of the food. All of these insects are injurious and the bird does a service by feeding upon them.

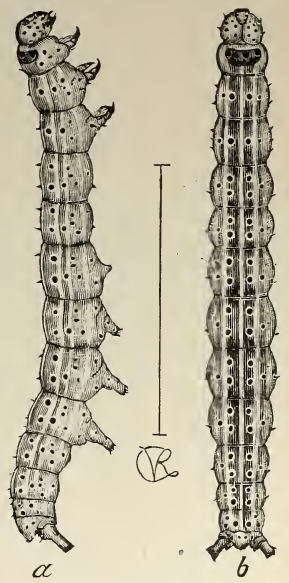

FIG. 20.—Cotton worm (*Alabama argillacea*). (From Riley, Bureau of Entomology.)

One parrot-bill was bold enough to swallow a large hornet (*Vespa* sp.). A few ants also were eaten, and these, together with spiders and snails, complete the list of animals devoured. Although this grosbeak is not conspicuously insectivorous, almost all the insects it eats are injurious.

Mineral Matter.

While mineral matter was absent from the majority of the stomachs examined, enough was contained in the remainder to make an average of 3.62 percent for the whole number.

Summary.

The present incomplete data indicate that for a grosbeak the parrot bill is decidedly vegetarian, preferring vegetable food even in months when insects abound. More than 69 percent of its food during August and September consists of weed seeds, the small

amount of grain taken bringing the total amount of vegetable food up to 71.19 percent. More than half of the total subsistence consists of grass seeds alone.

The 28.81 percent of animal food is made up almost exclusively of harmful species, among which are the most important pests of the cotton plant, namely, the cotton worm and the cotton boll weevil.

Although the data on hand are insufficient to determine the exact economic status of the bird, it may be stated with confidence that the gray grosbeak is almost entirely beneficial.

LIST OF SEEDS AND INVERTEBRATES EATEN BY THE GRAY GROSBEAK.

GRAIN.

Kafir corn (*Sorghum vulgare durra*).

WEEDS.

Joint grass (*Paspalum* sp.).
Crab grass (*Syntherisma* sp.).
Yellow foxtail (*Chætochloa glauca*).
Bur grass (*Cenchrus tribuloides*).
Wire grass (*Eleusine indica*).
Bindweed (*Polygonum* sp.).
Goosefoot (*Chenopodium* sp.).
Rough pigweed (*Amaranthus retroflexus*).
Pokeweed (*Phytolacca decandra*).
Carpetweed (*Mollugo verticillata*).
Sorrel (*Oxalis* sp.).
Spurge (*Euphorbia* sp.).
Croton (*Croton* sp.).
Mallow (*Malva* sp.).
Sida sp.
Vervain (*Verbena* sp.).
Nightshade (*Solanum* sp.).
Sunflower (*Helianthus* sp.).

COLEOPTERA.

Bronzy wood-borers (Buprestidæ).
Long-horned beetles (Cerambycidæ):
Liopus crassulus.
Hippopsis lemniscata.
Leaf-beetles (Chrysomelidæ):
Chlamys plicata.
Scarred snout-beetles (Otiorhynchidæ):
Compsus auricephalus.
True snout-beetles (Curculionidæ):
Anthonomus grandis.
Acalles sp.

HEMIPTERA.

Cicadas (Cicadidæ):
Cicada sp.
Leaf-hoppers (Jassidæ).
Lantern flies (Fulgoridæ).

ORTHOPTERA.

Short-horned grasshoppers (Acrididæ):
Syrbula admirabilis.
Long-horned grasshoppers (Locustidæ).

LEPIDOPTERA.

Owlet-moths (Noctuidæ):
Prodenia ornithogalli.
Alabama argillacea.

HYMENOPTERA.

Hornets (Vespidæ): *Vespa* sp.

Smooth-headed ants (Formicidæ).

NEUROPTERA.

Mantispidæ: *Mantispa* sp.

OTHER INVERTEBRATES.

Spiders (Araneida).

Snails (Gastropoda).

ROSE-BREASTED GROSBEAK.

(*Zamelodia ludoviciana*, Plate III.)

APPEARANCE, DISTRIBUTION, AND HABITS.

The rose-breasted grosbeak, one of the loveliest and most valuable of our North American birds, is easily recognized by its characteristic coloring and big bill. The male is gayly clad in rose, white, and black, the brightest tint partly covering the breast and lining the wings. The female, while soberly clothed in buffy, grayish, and brown, can not be mistaken, once the appearance of the species is familiar, the plump form and thick bill sufficiently distinguishing her.

The song of the male rosebreast is as charming as his appearance is striking, its notes being among the sweetest and most inspiring of the avian chorus. The bird seems never to tire of his music and may be heard during the hottest days and even at night. However, he is also a paragon of domesticity, taking turn with the female in incubating the eggs and later doing yeoman service in feeding the young.

The bulky and loosely-fashioned nest is built in June, and 3 or 4 eggs are laid. The nests are very often placed in orchard trees; indeed, where conditions permit, they are almost invariably in the vicinity of cultivated lands.

The birds are fairly common, especially in the northern part of their range, but they are not evenly distributed. For instance, in one locality, for no obvious reasons, grosbeaks are absent, while in another near by several pairs may live. In Wisconsin 7 nests have been found in a space of not over 5 acres, and on the brushy banks of a little stream in New Jersey 11 pairs nested within a quarter of a mile. If these figures held for any considerable area, they would indicate that the bird was very abundant, and indeed it would appear that in most accounts the number of rose-breasted grosbeaks has been underestimated, unless we are to assume that of late years the bird has increased in numbers greatly. In parts of New England

during the last twenty years the bird is known to have increased, and where once rare it is now common. In western Pennsylvania rosebreasts are said to be as common as song sparrows, and E. A. Preble, of the Biological Survey, found them in migration one of the commonest birds along the Athabaska River, near the northern limit of their distribution.

The rosebreast ranges farther north than any other of the group of grosbeaks here treated. Breeding from the latitude of St. Louis and northeastern Kansas and in the Alleghenies from southern Tennessee, it occurs as far north as Newfoundland and Quebec in the east and in the west extends through the Dakotas and lower Saskatchewan to Peace River Landing, Alberta, and the vicinity of Fort Smith, Mackenzie—the latter locality only 6° from the Arctic Circle. In winter the species is found from southern Mexico to below the Equator in Ecuador.

ECONOMIC RELATIONS.

Much interest attaches to the present species because of its well-known fondness for the Colorado potato beetle. More than 35 printed articles of greater or less length have been devoted to the bird because of this habit, and brief reports upon it appear in four previous publications of the Biological Survey.[a]

One hundred and seventy-six stomachs of the rosebreasted grosbeak are available for present examination, and these were obtained in the seven months from April to November (excepting October), from 17 States and the District of Columbia, besides Nova Scotia, Ontario, and Northwest Territory.

A detailed inventory of the contents of these stomachs having been made and the results tabulated, it was found that the bird consumes an average of 52 percent of animal matter and 48 percent of vegetable per month during its stay in the summer home. The maximum amount (74.25 percent) of animal food is taken in June, the nesting month. Remarkable features of the food habits are the apparent disinclination for grasshoppers and the strong preference for wild fruits.

Vegetable Food.

The vegetable part of the diet is composed of the following elements: Weed seed, 15.74 percent; grain, 5.09 percent; garden peas, 1.37 percent; wild fruit, 19.3 percent, and other vegetable matter, including a small quantity of cultivated fruit, besides buds, flowers of trees, etc., 6.5 percent.

[a] Barrows, W. B., Rep. Commr. Agr. (1888), 1889, pp. 535–536; Merriam, C. Hart, Rep. Commr. Agr., 1889, p. 369; Beal, F. E. L., Farmers' Bull. 54, 1897, pp. 28–30; Beal, F. E L., Farmers' Bull. 54, rev. ed., 1904, pp. 34–35.

BLACK-HEADED AND ROSE-BREASTED GROSBEAKS.

[Upper figures, black-headed grosbeaks, male and female; lower figures, rose-breasted grosbeaks, female and male.]

The items obtained from cultivated crops, being of chief interest, will be considered first. While it is needless to state that most of the testimony regarding the value of this bird is favorable, yet complaints of injury from it have been made which are verified by stomach examinations. The crop most frequently attacked by rosebreasted grosbeaks is the common garden pea.

PEAS.

Ten accounts from correspondence and published writings go to show that this grosbeak sometimes feeds upon peas. Six of them refer to damage in Iowa, two in Illinois, one in Massachusetts, and one general. Three persons regard the bird as very destructive; three, while stating that injury is committed, are less severe in their strictures; while the remaining four, admitting the consumption of a few peas, consider the bird's services in preying upon injurious insects ample compensation for the loss sustained.

The attacks of this bird upon peas were observed as early as 1839, W. B. O. Peabody [a] writing as follows:

> At the latter part of the summer, our gardens are frequented by the young in great numbers, and bitter complaints are made, with or without reason, of their depredations on the peas.

Among more recent charges of injury, that of H. J. Giddings, of Sabula, Iowa, may be cited, both because the amount of damage is extreme, and further because the observations are supported in part by stomach examination. Mr. Giddings says:

> During the last summer [1892] rosebreasted grosbeaks were unusually numerous here. * * * The last two weeks in June and the first week in July (after the young had left the nest) they became very destructive, eating all kinds of fruit and entirely destroying a small patch of green peas in my garden. (Nov. 18, 1892.)

Six grosbeak stomachs were sent in from this and other gardens where the birds had access to peas, but examination disclosed peas in only two of them, constituting in one case 10 percent of the stomach contents and in the other 80 percent. Peas were found in one other stomach also, of the 176 examined, this having been collected in Minnesota in July. It held 4 peas, which were 80 percent of the contents. Were there no other evidence, the above is sufficient to show that the rosebreast has a taste for green peas which is sometimes gratified at the expense of the gardener.

Some observers believe, however, that the bird makes full reparation for damage done. E. M. Hancock, of Waukon, Iowa, states:

> The rosebreasted grosbeak has more than made amends for its pea stealing by its determined warfare upon the Colorado potato beetle, helping very materially to keep down this pest. (April, 1886.)

[a] Birds of Massachusetts, 1839, p. 329.

Henry Nehrling[a] writes:

> It is said to eat green peas, and for this reason it is often killed, though the damage done in this way does not compare with the many benefits it bestows.

The question is, Do stomach examinations support this view? Years ago Prof. F. E. L. Beal observed the rosebreast in the act of eating peas and found the pods cut open and the peas gone; the contents of a stomach were examined, and two or three peas, several potato beetles, and a tomato worm were found; whence it is evident that this particular grosbeak, at least, was paying well for its peas.

In this connection the record of 6 birds from Iowa gardens is of interest. Fifteen percent of their food was peas, and to that extent, of course, they were detrimental; but as an offset more than 17 percent consisted of bronzy wood-borers and 12.5 percent of weevils, including the injurious pine bark-weevil and 2 nut weevils. While these insects are very injurious to timber, it may be claimed that they are not of direct consequence to the gardener. But insects especially injurious to garden crops also were consumed, 14.8 percent of the food consisting of white grubs, which are enemies of strawberries, and a flower beetle, which injures young corn and many fruits, besides the notorious Colorado potato beetle. Caterpillars and ants also were preyed upon by these 6 birds, and scale insects (*Eulecanium* sp.), the very worst pest of fruit trees, formed 4.5 percent of their food. The gardener is vitally concerned in reducing the numbers of these insects, and it is evident that the 15 percent of peas consumed is paid for many times over by the destruction of more than three times that amount of garden and forest enemies. Moreover, to determine the true significance of the damage done, not only the birds which had eaten peas, but the species collectively must be considered. The present investigation shows that 3 birds out of 176 had stolen peas, while scores had literally feasted upon the worst enemies of agriculture. Peas constitute 1.36 percent of the total food of the grosbeaks examined, while noxious insects certainly compose thirty times as much. Viewed in the light of these facts, the loss sustained would be nothing compared to the benefits received were it not for the fact that the birds' depredations are often local in character, as in the case cited above, one cultivator, perhaps, furnishing the supply of peas for all the grosbeaks in the neighborhood.

However, even under such circumstances a remedy is available without the necessity of sacrificing the birds. Wire guards or bird netting afford protection, and in the case cited above Professor Beal at once stopped the grosbeaks' visits to his pea patch by means of an old coat on a pole.

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[a] Our Native Birds of Song and Beauty, II, 1896, p. 206.

GRAIN.

Grain composes 5.09 percent of the food of the 176 rose-breasted grosbeaks examined, the cereals selected being corn, wheat, and oats. The bird has been accused of injuring each of these products, and stomach examinations lend support to the complaints.

Corn.—Part of the damage to corn is of an unusual nature. H. S. Giddings, of Sabula, Iowa, writing about the same grosbeaks mentioned above as injurious to peas, says:

> From the time they arrived until their departure they fed continuously on corn from a crib on my place. * * * Sometimes as many as 10 or 12 would be in the crib at once.

The stomachs of 3 grosbeaks shot at this time contained corn, the grain constituting in each case about half the contents. Notwithstanding these facts, it is very doubtful if any considerable damage is ever committed in the manner described, if for no other reason than that the opportunity is seldom presented. Moreover, such depredations are easily prevented by simple and inexpensive means, such as lining the crib with wire netting and closing the doors when not in use. These precautions will not only keep out wild birds, but also rats, mice, and chickens, which animals undoubtedly destroy vastly more stored grain than all native birds together.

A small quantity of the corn eaten by the rose-breasted grosbeak may be pilfered from the growing crop, one bird taken in Pennsylvania in July having eaten enough corn to form 8 percent of its stomach contents, and one from Illinois in September consumed 50 percent. There is no way of determining positively whether this grain was crop corn or waste; but if only 2 grosbeaks out of 176 take corn from the ear, there is no cause for alarm. The corn obtained in May by 2 other rosebreasts from Illinois and Minnesota may have been either seed or waste.

Oats.—Seed oats may sometimes be devoured by grosbeaks. E. A. Mearns says:[a]

> Where fields newly sown with the cereal grains are convenient to its woodland retreats, it * * * will collect in large flocks, and resort there continually, as long as there is a grain of seed to be had.

As this statement refers to a locality in New York where the rosebreast occurs only from May to September, the crop in question must be oats.

This grain was eaten by 5 of the birds examined, 4 of which may have obtained it from newly sown fields, but even this trifling injury to the crop may be prevented and other advantages secured by drilling. The fifth grosbeak, which was collected in Illinois in July, probably obtained the oats it devoured from standing grain.

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[a] Bull. Essex Inst., 12, 1880, p. 21.

Wheat.—A certain quantity of wheat also may be taken from the heads, but no complaints of such damage have been received, the only observation at hand which bears upon the point being that of Audubon. Referring to a brood of young rose-breasted grosbeaks in the vicinity of Cincinnati, he says:[a] "The parents fed them on the soft grains of wheat which they procured in a neighboring field." Four grosbeaks out of the 176 examined had fed upon wheat. That obtained by 1 collected in Connecticut in May is obviously waste, but 3 birds, which had eaten wheat during July and August in Iowa and Illinois, may have attacked standing grain. These 4 birds obtained about 3 kernels of wheat each, which is an average of less than a fourteenth of a kernel apiece for the 176 grosbeaks examined. Now, if the proportion of grosbeaks eating wheat, 4 to 176, or thereabouts, holds true for this species at large, and the birds do not exceed the moderate average of 3 kernels each, it would require the united efforts of the grain eaters among some 300,000 grosbeaks to consume a quart (21,000 kernels) of average wheat. It is evident, therefore, that the rosebreast's wheat-eating habits can not be termed injurious.

To sum up the rosebreast's relation to grain crops, as shown by the present investigation, 15 birds out of a total of 176 fed upon grain, including oats, wheat, and corn. Wheat and corn eaten by 4 of these very probably was waste, while 3 birds had taken corn from a crib, and 4 had eaten oats which may have come from newly sown fields. In both cases the injury was easily preventable. Six grosbeaks, consuming one or the other of the grains mentioned, may have pilfered standing crops. This latter injury to grain constitutes the only real case against the bird, and involves only 1.17 percent of the total food of the birds examined. If this ratio holds true for the entire species, the damage is of no special consequence. This view is further strengthened by the fact that no complaints have been made of injury to standing grain, the only stage in which it is subject to attack under the best methods of culture.

BUDS.

All grosbeaks are usually thought to feed much on buds, and none of the species are believed to be more fond of them than the rosebreast. Most writers have commented on this habit of the rosebreast, and it is referred to also by many correspondents. However, buds were found in but 2 of the stomachs examined, while flowers of trees were found in 4, and it is quite possible that more of the records of field observers relate to flowers than to buds. Among trees whose buds are said to be devoured are beech, cherry, pear, wild plum, soft

[a] Birds of America, III, 1841, p. 210.

maple, box elder, and elm. Apparently some of these are greatly relished. G. E. Atkinson, of Ontario, says:[a]

> They cut off the buds [of beech] close to the twig, eat the soft pip, and drop the shells. On May 11, I * * * saw three rose-breasted grosbeaks feeding, * * * occasionally darting out at a passing insect. I managed to secure one and its stomach was packed with these buds.

The practical significance of the rosebreast's budding has been the subject of widely varying opinions. Seventeen statements concerning the subject are at hand, which, briefly put, are as follows: One author holds the grosbeak injurious; one thinks it may possibly be so; two perceive very little damage; one considers any detriment in this way fully recompensed by the bird's utility in other directions; ten assert that no harm whatever is done, and two declare that budding is beneficial. It will be of interest to cite in full some of these diverse opinions. E. A. Mearns writes:[b]

> Soon after its arrival, the rose-breasted grosbeak appears about our houses, and, possibly, does some damage to the fruit crops by eating the blossoms in the orchards; it is especially fond of those of the cherry, and the rapidity with which it dispatches them is quite marvelous.

H. D. Minot says:[c]

> He * * * eats buds, often committing depredations on our fruit trees; and he must be considered as injurious to agriculture. He frequently plucks blossoms, and, dexterously cutting off the petals, etc., lets them fall, while he retains the ovary which contains the seeds.

Commenting upon the latter author's statement, William Brewster observes:[d]

> There are no good reasons for assuming that this injures the trees or even their crops of fruit. On the contrary, both are probably benefited by the process, which is, in effect, a sort of fruit pruning, seldom if ever more severe than that practiced by the thrifty horticulturists.

It will have been noted that the above quotations refer to flowers, which, as previously stated, seem to be eaten much more commonly than leaf buds. Dr. B. H. Warren found flowers of hickory in 11 stomachs, those of beech in 26, maple in 3, and other blossoms in 23 stomachs collected during May in Pennsylvania. Dr. A. K. Fisher has observed rosebreasts feeding on the flowers of elm and walnut, and during the present investigation flowers of oaks were found in 4 stomachs, the blossoms in two of them being of the post oak (*Quercus minor*). No appreciable damage ensues from the bird's habit of feeding on the flowers of forest trees, since the fruits of these trees

[a] Trans. Canad. Inst., III (1890–91), 1892, p. 40.

[b] Bright Feathers of North American Birds of Beauty, F. R. Rathbun, 1881, pp. 31–32.

[c] Land Birds and Game Birds of New England, 2d ed., 1895, p. 241.

[d] Loc. cit.

are of little economic value. Moreover, it is noticeable that the fruit-producing or pistillate flowers are not the ones preferred, but the sterile staminate ones. These are produced in countless millions, and wither and fall away after a short season. All of the plants named above, whose seeds are even occasionally utilized by man, such as the hickories, walnuts, beech, and oaks, have the staminate and pistillate flowers separate, while no use is made of the seeds of the maple and elm, which have both sexes present in a single flower.

Buds were found in but 2 stomachs, those in one being identified as poplar, and remains of tender young shoots of some woody plant were eaten by another grosbeak. These results indicate a much slighter preference for buds than the bird is usually credited with. But even admitting that the bird relishes buds, it is difficult to conceive how forest and shade trees, numerous as they are, can possibly be injured, since the rosebreast never gathers in large flocks during the budding season. With fruit trees the case is different, for an isolated tree in a home garden may receive the attentions of several birds at the same time. But even then the chance of injury is slight, and in the majority of cases the tree, as stated above, receives no more than a beneficial pruning.

CULTIVATED FRUIT.

The rosebreast is said to feed occasionally on cultivated fruits, but no complaints of serious injury by the bird have been received. Most observers state that they lose but little fruit by grosbeaks, and this is considered only partial payment for services rendered. One correspondent, after mentioning the fact that the birds eat the potato beetle, says:

> They also feed on my berries. Still I plant enough for all, and put up with the loss for the sake of their good qualities.

The rosebreast is reported to attack cherries, currants, and other berries. During the examination of stomachs, however, cultivated fruit was found to have been eaten by only 1 grosbeak. This bird and a companion were collected in a cherry tree in Massachusetts, where they were suspected of pilfering the fruit. One had eaten perhaps a single mouthful of cherry, which constituted 18 percent of its stomach contents, and had eaten also some weevils, stink bugs, and a potato beetle, all highly injurious insects. Several other grosbeaks of the present collection were killed because they were thought to be eating fruit, but their stomachs yielded no trace of it.

WILD FRUIT.

While cultivated fruit is a negligible item of the rosebreasted grosbeak's bill of fare, wild fruit, on the contrary, is the most important single article, constituting 19.3 percent, or almost a fifth of

the total food. Many different kinds of fruit are eaten, among which elderberries are probably of most importance. Both the common sweet elder (*Sambucus canadensis*) and the red-berried elder (*S. pubens*) were identified. Nineteen birds had eaten these fruits, which often composed from 60 to 90 percent of the stomach contents. In the gizzard of 1 grosbeak were found fully 200 seeds, which means that no less than 40 to 50 berries were taken at one meal. Blackberries and raspberries rank next in preference, 17 birds having eaten them, and they sometimes constitute 80 percent of the food of individual birds.

Mulberries also are relished, the rosebreast often being observed feeding on the wild red mulberry (*Morus rubra*). June berries (*Amelanchier canadensis*, Plate II, fig. 3) were eaten by 3 of the grosbeaks examined, 80 seeds being discovered in 1 stomach. Eight or more of these rather large fruits must therefore have been taken by this bird. Among other wild fruits eaten by the birds examined are wild red and black cherries (Plate II, fig. 1), choke cherry, rough-leaved dogwood (Plate II, fig. 6), wintergreen, checkerberry, red haw, strawberry, supple-jack, and pokeberry (Plate II, fig. 4). In addition to these, authors and correspondents add flowering dogwood (Plate II, fig. 5), juniper, and sour gum.

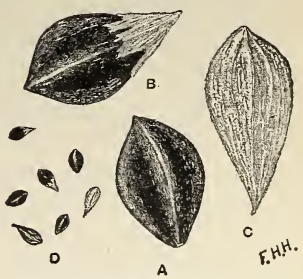

FIG. 21.—Seeds of black bindweed (*Polygonum convolvulus*). (From Hillman, Nevada Experiment Station.)

WEEDS.

Although this grosbeak is not particularly fond of the seeds of weeds, it takes part in the warfare which birds wage against these misplaced plants, and attacks some very troublesome species. Fifteen and three-fourths percent of the bird's food is composed of weed seed, and a greater proportion is consumed in August and September than in other months. The seeds of smartweed and bindweed (fig. 21), species unfavorably known both in country and town, were selected by the greater number of rosebreasts. Those of tumbleweed or amaranth (fig. 18) are next in favor, and when eaten at all almost invariably compose the major part of the stomach contents. These weeds are obnoxious almost everywhere, and their bad qualities are universally acknowledged. Seeds of foxtail (figs. 17 and 37), highly valued in the dietary of many birds, were fed upon by but 2 rose-breasted grosbeaks, and other grass seeds—a small wild oat in 2 cases—were eaten by 4 of the birds examined. Nightshade and sedge seeds were each selected by the same number of birds. The akenes of both common (fig. 6) and giant ragweed were sampled, and

the seeds of vervain (fig. 3) and dock are occasionally devoured. Milkweed and sunflower are added to this list by other writers.

MISCELLANEOUS VEGETABLE FOOD.

The rosebreast feeds upon some vegetable matter which does not fall into any of the previously discussed categories. Seeds of the touch-me-not and blood-root, plants widely known for their flowers, are examples. Each was eaten by 1 individual, and 1 fed upon redbud seeds also, which constituted 80 per cent of its stomach contents. The spiny, globe-like fruits of the sweet gum (*Liquidambar styraciflua*) are bitten into occasionally, but the remains found in the stomach so resemble another but unknown substance that it was possible to identify them certainly in only one instance, and then by means of the very characteristic fertile seeds. The pendent sycamore balls are sometimes rifled of their seed, as also are the aments of alder and birch.

Among the objects most puzzling to classify economically are the curious excrescences of plants, known as galls. These, as is well known, are nurseries for insects, within which the larvæ develop. They are eaten by many birds, extensively by some, and in an instance cited by Dr. A. D. Hopkins,[a] turkeys, chickens, and even hogs and cattle fattened on an abundant gall of the black oak, known in Missouri and Arkansas as "oak wheat" or "wheat mast." An analysis accompanies this note which leaves no doubt that the nourishing elements of galls are of vegetable, not animal, origin. Although this may not be true of all galls, such as certain thin-walled kinds made by plant lice in which at the proper stage the bulk of the imprisoned insects exceeds that of the shell, yet generally, no doubt, it is safe to classify galls as vegetable food. This has been done in the case of those eaten by grosbeaks. Nine rosebreasts had eaten galls, but in only one instance did they compose as much as half the food. The galls eaten appeared to be similar to the spherical species common on oaks.

ANIMAL FOOD.

Animal food, consisting almost exclusively of insects, composes 52 percent of the food of the rose-breasted grosbeak. Nearly 36 percent is beetles, 3.82 percent caterpillars, 6.43 percent Hymenoptera, and 2.38 percent scale insects, the remainder (about 3.33 percent) being made up from several other groups of invertebrates. While the rosebreast feeds upon a large number of formidable insect pests, it devours some beneficial species also. The latter are accorded prior consideration.

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[a] Proc. Ent. Soc. Wash., V, 1903, pp. 151–152.

As just noted, almost 6.5 percent of the total food is Hymenoptera, and as this group contains some of the most useful of all insects, it must be ascertained how many, if any, of these forms fall a prey to the bird. The beneficial Hymenoptera are the small parasitic species, the eggs of which are deposited in the bodies of caterpillars and in the eggs of many insects, to develop there and later destroy their hosts, and the larger wasps, which store up caterpillars and other creatures as food for their young. Very few parasitic species were found in the stomachs, the larger Hymenoptera apparently being preferred. In many cases a single wasp composed from 40 to 90 percent of the stomach contents of individual grosbeaks. It is possible that among these are some of the highly beneficial solitary wasps, but the probabilities are that most of them belong to the more abundant, gregarious species, which although often beneficial would lose little by the destruction of few of their number.

Fifty-four of the 176 grosbeaks examined were found to have eaten Hymenoptera of some sort, which shows that the bird has a decided liking for these insects; but, as just mentioned, few beneficial species are eaten, while a number of injurious ones are devoured. One grosbeak secured a cuckoo fly (*Chrysis* sp.), which is a parasite of the useful solitary wasps. Three fed upon sawfly larvæ, which have habits like caterpillars, and are injurious to roses, currants, pear, willow, and other plants. One bird when collected had 10 sawfly larvæ in its beak, which it was probably gathering for its young; while in the stomach of another grosbeak were 24 of these larvæ, which constituted 60 percent of the contents. The few ants taken are injurious, especially those of the genus *Camponotus*, which sometimes devour the wood of living trees, hollowing them out to mere shells. Two rosebreasts ate little mining bees (*Andrena*), one consuming 26 of these and nothing else. They have no special economic significance except as carriers of pollen.

Passing now to beetles, this grosbeak was found to prey upon members of three useful families, the ground-beetles (Carabidæ), ladybirds (Coccinellidæ), and fireflies (Lampyridæ). Seven birds ate predaceous ground-beetles, but since they compose only a little more than 0.5 percent of the food from May to September, little harm is done. One of the 7 grosbeaks captured a large shining black ground-beetle (*Pasimachus depressus*), which is about an inch in length and is one of the most powerful insects of the family.

Three birds ate coccinellid beetles, one securing a twice-stabbed ladybird (*Chilocorus bivulnerus*), a noted enemy of scale insects. If many such beetles were eaten, damage would be done, but as they compose less than 0.2 percent of the total food, it is evident that only occasionally one is snapped up. Moreover, the grosbeak compensates

for any injury done in this way by feeding upon the prey of these beetles—the scale insects.

Fireflies, which are predaceous both in the larval and adult stage, are constantly fed upon by grosbeaks. These insects are supposed to be excellent examples of protected species, having the power of secreting nauseous juices, while the "fire" is supposed to act as a warning signal and certify the bearer's identity to its enemies. It is said that some birds refuse them. However, since 28 rose-breasted grosbeaks fed upon them and 6 to 12 of the beetles were found in single stomachs, they must be relished by this species at least. Fireflies prey upon many important agricultural pests; hence the destruction of any considerable number of them is a loss; and while but 2.71 percent of the grosbeak's food consists of these useful beetles, the bird is chargeable with a distinctively injurious habit.

Thus far only a fourth of the rosebreast's animal food has been discussed. Less than half this amount, or only about a tenth of the total animal matter, is made up of beneficial insects whose destruction is a loss to man. The remaining nine-tenths consists in part of insects of neutral import, but mostly of positively injurious species.

FIG. 22.—Pine buprestid (*Chalcophora virginiensis*). (Marx del. Bureau of Entomology.

Included in the latter category are the bronzy wood-borers (Buprestidæ), among the most serious pests to fruit and forest trees. The larvæ, known as flat-headed borers, do the mischief, often killing trees by completely girdling them just under the outer bark. The adults are incased in a glittering coat of hardest mail, and although they expose themselves on flowers and leaves or on the limbs of trees, they are not fed upon to a marked degree by most birds. The rose-breasted grosbeak, however, seems to relish them, 3.02 percent of its food being composed of these well-protected beetles. The larger species are sometimes captured, one grosbeak having obtained the bulky buprestid *Chalcophora virginiensis* (fig. 22), which is very destructive to pines. This species is an inch in length and as firm and hard as a nut. Smaller species of another genus (*Dicerca*, including *D. obscura*), which feed on hickory and other deciduous trees, also are devoured. Many others not identified were eaten by the 26 grosbeaks which secured buprestids, and the rosebreast must be characterized as one of the important enemies of these beetles.

Resembling the buprestids in compact build and equaling them in evil qualities are the click-beetles (Elateridæ), the larvæ of which are commonly known as wireworms. Their attacks on meadow-grass, grains, and strawberries are of annual occurrence, and result in much damage. Twenty-three grosbeaks, or about one-seventh of

the number examined, devoured click-beetles, thus benefiting the farmer considerably.

Not so many of the birds fed upon long-horned borers, but the resulting benefits are less valuable only in degree, as the beetles of this family are often disastrous pests. They are frequently large and strikingly colored, and one of the handsomest, as well as the most injurious kinds, the painted hickory borer (*Cyllene pictus*) is eaten by the rosebreast. This insect is known as the commonest and most destructive pest of the hickory. Another borer also (*Phymatodes varius*), which lives in dead wood, and which is sometimes injurious to the tanbark industry in the South, is devoured.

The rosebreast shows particular fondness for large beetles, a taste readily gratified among the lamellicorn or scarabæid beetles. Among these larger species, beetles of the genus *Dichelonycha*, which feed upon flowers and sometimes are destructive to cultivated plants, were eaten by 9 rosebreasts. Six ate cetoniids (*Euphoria fulgida*, et al.), which are especially adapted for feeding on flowers, and which also at times turn their attention to fruit and the tassels, silk, and young grains of corn. The beautiful and bulky goldsmith beetle, about three-fourths of an inch long, is captured occasionally, and for this service the bird is to be commended, as sometimes the larvæ are very destructive to strawberries. A white grub or larva of a june-bug was the plump morsel obtained by another grosbeak. The ravages of this beetle in lawns and strawberry plots are well known. The bird feeds also upon another good-sized scarabæid (*Anomala binotata*), which injures grapes and other plants.

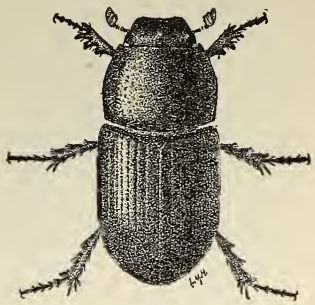

FIG. 23.—Seed corn scarabæid (*Aphodius granarius*). (From Forbes, Illinois Experiment Station.)

Among the smaller members of this family the dung beetles, which occur in large numbers, flying near the ground along country roads, are frequently captured by this grosbeak. Most of them are of neutral economic position, but one species (*Aphodius granarius*, fig. 23), burrows into sprouting corn. Having this bad habit, the farmer is indebted to the grosbeak for preying upon it.

Passing to a group of beetles, the weevils, which are an important element of the food of most birds, and which are so uniformly injurious that almost any one of them may be deemed a pest, it is gratifying to note that the rosebreast does its share toward checking them. Moreover, among the kinds it eats is one of the very worst enemies of cultivated fruit in the United States, namely, the plum curculio (*Conotrachelus nenuphar*, fig. 24). One grosbeak devoured

three of these destructive weevils, which may be taken as indicating that an opportunity to feed on them is not overlooked. In this connection it is of interest to recall the other birds that are known to prey upon this pest. They are 8 in number: Great-crested flycatcher, Baltimore and orchard orioles, yellow-throated vireo, bank swallow, veery, hermit thrush, and bluebird. The grosbeak does not confine itself to the plum curculio, but evinces a taste for related species, two of which were identified. These infest the hackberry and hickory, respectively. A fourth kind was present in the stomachs, but could not be assigned a specific name. The curculios destroy a large proportion of the fruit of the trees they attack, and are capable of doing vast damage; hence the services of the birds that devour them are of great value.

Related to the curculios are the nut weevils (*Balaninus*), which attack their favorite plants in much the same way, and often ruin the crop of nut-bearing trees. Six grosbeaks ate from 1 to 3 each of these weevils, one bird capturing 2 acorn weevils (*B. nasicus*). Another curculionid (*Hylobius pales*), which feeds both in living pine trees and pine logs, is included in the grosbeak's diet, and a weevil (*Ampeloglypter sesostris*), which infests the Virginia creeper, was highly relished by an Illinois rosebreast, 11 being eaten, which constituted 74 percent of the stomach contents. Others in the same group are consumed, as many as 4 or 5 being eaten by individuals of the more than 20 birds which fed upon them.

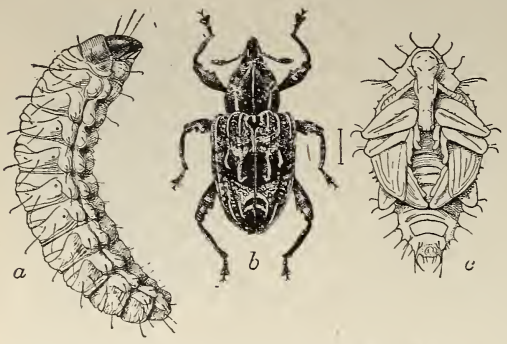

FIG. 24.—Plum curculio (*Conotrachelus nenuphar*). (From Chittenden, Bureau of Entomology.)

A second family of weevils, the scarred snout-beetles, also contributes to the fare of this grosbeak, and four of them composed 87 percent of the food of one bird; while another rosebreast, one of four which fed upon clover weevils (*Sitones*), captured 13. Billbugs (Calandridæ) are represented in the bird's diet by the conspicuously red and black colored snout-beetle (*Rhodobaenus 13-punctatus*), common on thoroughwort (*Eupatorium*). A weevil of yet another branch of the suborder is sometimes devoured, namely, the peculiar brenthid (*Eupsalis minuta*), a very slender weevil which bores into living oak. Altogether weevils constitute 3.64 per cent of the rosebreast's food, in which amount are included several great pests; hence the bird's weevil-eating propensities result in much benefit to man.

There remains for consideration the family of beetles which contributes most largely to the grosbeak's subsistence, namely, the leaf-beetles (Chrysomelidæ). This family, as an item of food of the rosebreast, is not only most important among beetles, but is only second among both animal and vegetable items. In it are included a number of pests preyed upon by the bird, such as the striped and spotted cucumber beetles, the strawberry rootworm, the plum leaf-beetle, the locust leaf-miner, and in addition that pest which figures so largely in any discussion of the economic value of the rose-breasted grosbeak, the notorious Colorado potato beetle (fig. 25).

The original home of this insect was in Mexico and the Rocky Mountains, where it fed upon the sand-bur (*Solanum rostratum*), a plant closely related to the potato. Finding a new and abundant supply of food in the cultivated potato, the beetle immediately began to multiply and to migrate eastward, spreading from 1850 to 1874 over the northern half of the eastern United States. As it encountered practically no enemies in its new home it became so abundant and inflicted so great damage that successful cultivation of potatoes seemed no longer possible. However, just as the beetle found a new food, so it in turn became new food to a number of mammals, birds, and insects, and presently the farmers learned to destroy it in large numbers with poisons. Hence it is no longer greatly dreaded, though in most sections constant vigilance must be exercised to prevent it from ruining the crop.

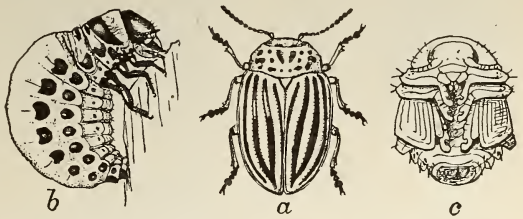

FIG. 25.—Potato beetle (*Leptinotarsa decemlineata*). (From Chittenden, Bureau of Entomology.)

Naturally during the period when the beetle was doing most damage everyone was on the lookout for means of checking its increase, and the discovery of each new natural enemy was heralded far and wide. Attracting most notice among these was the rose-breasted grosbeak, and many articles were written calling attention to the newly discovered trait of this beautiful bird. It should be noted also that several other birds, including the bobwhite, prairie chicken, sharp-tailed and ruffed grouse, red-tailed hawk, nighthawk, cuckoo, crow, English sparrow, cardinal, scarlet tanager, wood, hermit, and olive-backed thrushes, and robin, eat potato beetles occasionally.

The grosbeak's habit of feeding on the potato beetle was noted almost simultaneously in many localities, and references are at hand for the States of Missouri, Iowa, Minnesota, Wisconsin, Illinois, Michigan, and Ohio. The rosebreast actually exterminated the po-

tato beetle in many patches it patrolled. Mr. W. F. Bundy,[a] who was among the earliest to write upon the subject, says:

> I noticed last summer that great numbers of the Colorado potato beetles were destroyed by the rosebreasted grosbeak. * * * They were so abundant in this region [Jefferson, Wis.] * * * as to hold in check the vast army of these ravagers of the potato crop.

The beetles are attacked as soon as they emerge from their winter quarters, according to Mr. J. S. Cook,[b] of northern Illinois, who says:

> I have seen them so gorge themselves with these beetles that they were scarcely able to fly. I have investigated in the spring, when the beetles first came out of the ground, and was unable to find a single one after following these birds.

Further testimony to the value of the bird is given by Prof. F. E. L. Beal,[c] who watched the grosbeaks and their young feeding upon the potato bugs in his garden at Ames, Iowa:

> When a careful inspection was made a few days later not a beetle, old or young, could be found; the birds had swept them from the field and saved the potatoes.

Comparison of the dates of the first appearance of the Colorado beetle with the earliest records when the rose-breasted grosbeak fed upon it shows that from six to ten years passed before the bird commonly began to prey upon the insect. Even after the lapse of so much time it was one of the first enemies of the beetle noted and by far the most important among birds.

The results of stomach examinations fully corroborate the testimony of field observers as to the extent to which the rosebreast feeds upon this beetle. Forty-three, or almost one-fourth of the birds examined, fed upon the potato beetle to such an extent that the insect makes up 9.05 percent of the subsistence of the entire number and nearly 35 percent of that of the individuals eating it. The significance of these figures will be better appreciated when it is considered that the potato beetle probably was not obtainable by many of the grosbeaks, and furthermore, that it is very unusual for birds to prey so extensively upon a single kind of insect, or even on the species collectively of a whole group. Such concentration of attack of a common bird upon a single species of insect, however numerous, can not but have a restraining influence on its numbers. The beetle is fed upon from May to September and both larvæ and adults are devoured, 10 to 14 being found in single stomachs. By feeding upon the larvæ the rosebreast directly benefits the potato plants, and by destroying adults the increase of the species is checked.

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[a] Am. Nat., IX, 1875, p. 375.

[b] Trans. Ill. Hort. Soc., 37 (1903), 1904, pp. 331–332.

[c] U. S. Dept. Agr., Farmers' Bul. 54, 1904, p. 35.

Although the potato beetle is the worst pest in the Chrysomelidæ, this family contains other serious enemies of crops. The rosebreast feeds upon several of them, thereby further commending itself to our esteem. Both the small striped and the spotted cucumber beetles (fig. 26), which are abundant and injurious over much of the United States, are consumed. The importance of the bird's inroads upon one of these little black and yellow species, which in the larval stage is the destructive corn root-worm, is emphasized by the fact that no direct method of combating the insect has yet been devised. Twelve grosbeaks fed upon these beetles, as many as 7 being found in a single stomach. Further evidence of the bird's strong preference for them is furnished by Mr. Ridgway, who observed a number of rosebreasts feeding exclusively on spotted cucumber beetles in a locality where the latter were very abundant.

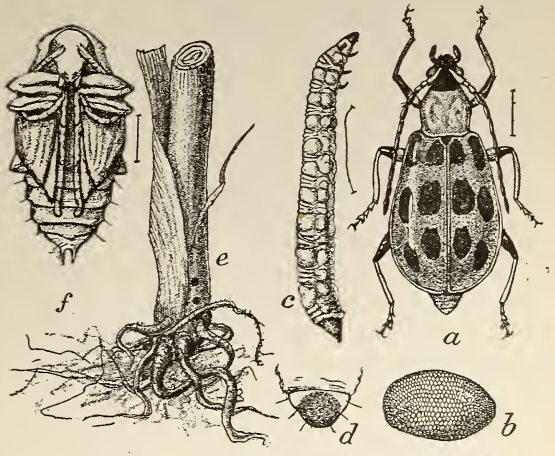

FIG. 26.—Spotted cucumber-beetle (*Diabrotica 12-punctata*). (From Riley and Chittenden, Bureau of Entomology.)

Ten of the grosbeaks examined had eaten another kind of leaf-beetle (*Melasoma lapponica*), which feeds on willows and poplars, sometimes working havoc by defoliating trees, especially in windbreaks. These beetles appear to be much relished, as from 10 to 27 were taken by individual rosebreasts, of whose food they composed from 60 to almost 100 percent. Two or three other species of Chrysomelidæ, injurious to willows, to grapes, and to garden crops, are devoured. Nine birds ate beetles of one of these species (*Calligrapha bigsbyana*), which in individual cases constituted 70 per cent of the stomach contents. The rosebreast devours also two Hispid leaf-beetles, one of which causes considerable injury. This is the locust leaf-miner (*Odontota dorsalis*), which sometimes devastates whole groups of trees, leaving them as if scorched by fire. Eight grosbeaks had eaten leaf-miners, and in one case 8 were consumed by a single bird.

The long list of beetles of this family that are preyed upon by the rosebreast is completed by the strawberry root-worm (*Typophorus*

canellus), which at times is very destructive, the plum leaf-beetle (*Nodonota tristis*), which causes dropping of cotton bolls, a species (*Griburius equestris*) which feeds on wild roses, and another wild-flower beetle (*Cryptocephalus quadrimaculatus*).

With the Chrysomelidæ is concluded also the list of principal Coleopterous families. The grosbeak eats few others. One rose-breast devoured 5 of the decidedly malodorous burying beetles (*Silpha noveboracensis*), which feed on carrion, while another captured one hard, polished *Hister*, an insect of similar habits. Sixteen of the little orange and black *Ips fasciatus* were secured by one of the three birds which fed upon this occasional depredator of stored vegetables and grain.

It thus appears that a large number of the beetle enemies of agriculture are preyed upon by the rose-breasted grosbeak. An almost equal array of serious pests is secured from the ranks of another order, which is eaten to only one-ninth the extent that beetles are, namely, the moth and butterfly order or Lepidoptera.

This group may be discussed conveniently under the heads "larvæ" and "adults." The latter do not seem to be eaten to any great extent by birds, and only 2 rosebreasts fed upon them. Four moths were secured, but they composed less than 0.2 percent of the total food. The larvæ or caterpillars, however, are more generally relished by birds and often are eaten in large numbers. Twenty-two out of the 176 rosebreasts had eaten caterpillars, some of them securing from 6 to 14 each, which usually constituted from 50 to 85 percent of the stomach contents. They make up 3.82 percent of the entire food of all the rosebreasts examined.

It is well known that at times the depredations of lepidopterous insects, such as canker worms, tent caterpillars, gipsy moths, and many others, are very serious, threatening ruin to orchards and even large forests, and thus becoming of State, if not National, importance. The difficulties encountered in combating such pests render the aid of natural enemies most valuable. It should be widely known that the rose-breasted grosbeak is conspicuous among the enemies of these insects, and also that it feeds upon no fewer than eight of the very worst lepidopterous pests.

Among the more widely known of these are the canker worms, which are very destructive to both orchards and woodlands. They often strip orchards so that they appear as if fire swept, and when their attacks are continued for a few years the trees die. The rose-breasted grosbeak devours both the spring canker worm (*Paleacrita vernata*, fig. 35) and the fall canker worm (*Alsophila pometaria*, fig. 27). Two birds collected in Illinois in May had fed upon the former caterpillar, while O. W. Knight testifies that in Pleasant Valley, Me., the birds actively attack the other.

The dreaded army worm (*Heliophila unipuncta*, fig. 28), which sometimes appears in myriads and devastate fields of grain and grass, also is the prey of this beautiful grosbeak. A bird from Illinois in July had captured 6 of these destructive caterpillars.

The tent-caterpillars are another group of noxious lepidopterous insects, which are common in many parts of the United States. They greatly damage orchards, as well as shade and woodland trees. E. H. Forbush[a] is authority for the statement that the rose-breasted grosbeak preys upon the orchard tent-caterpillar (*Malacosoma americana*, fig. 29), and Prof. C. M. Weed[b] reports that the bird devours moths, larvæ, and pupæ of the forest tent-caterpillar (*M. disstria*).

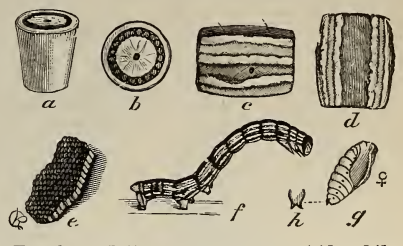

FIG. 27.—Fall cankerworm (*Alsophila pometaria*). (From Riley, Bureau of Entomology.)

Two other insects of this order, which are usually thought of together and which indeed are closely related, are the gipsy moth (fig. 30) and the brown-tailed moth (fig. 31). Mere mention of their names calls to mind the enormous damage done by them in the State of Massachusetts, and of the costly efforts being made to stamp out these disastrous invaders from across the sea. Birds have proved of service as allies in this struggle, and the present species is by no means least in importance among them. In the original report[c] on the gipsy moth, as well as in later publications,[d] the rosebreast is listed among the species devouring the larvæ, while in regard to the brown-tail moth Messrs. Mosher and Kirkland report[e] that "a rose-breasted grosbeak ate 57 caterpillars in twenty minutes."

FIG. 28.—Army worm (*Heliophila unipuncta*). (From Chittenden, Bureau of Entomology.)

This species eats hairy and spiny caterpillars as readily as smooth ones, and the idea so often advanced that such hairy armature is effective protection against the attack of birds receives little support from the food habits of the grosbeaks. Tussock and gipsy moths and both of the tent caterpillars are devoured, though very hairy. The

[a] Mass. State Bd. Agr. Rep. (1900), 1901, p. 315.
[b] N. H. Exp. Sta. Bull. 75, 1900, p. 121.
[c] Forbush, E. H., and Fernald, C. H., The Gipsy Moth, 1896, p. 219.
[d] Forbush, E. H., Mass. State Bd. Agr. Rep. (1900), 1901, p. 313.
[e] Forbush, E. H., Mass. State Bd. Agr. Rep., 1899, p. 322.

browntail, the hairs of which so irritate human flesh, also is eagerly eaten, and other caterpillars clothed with spines were found in the stomachs examined. In several gizzards, indeed, a mass of branching caterpillar spines was all that remained to show the nature of the

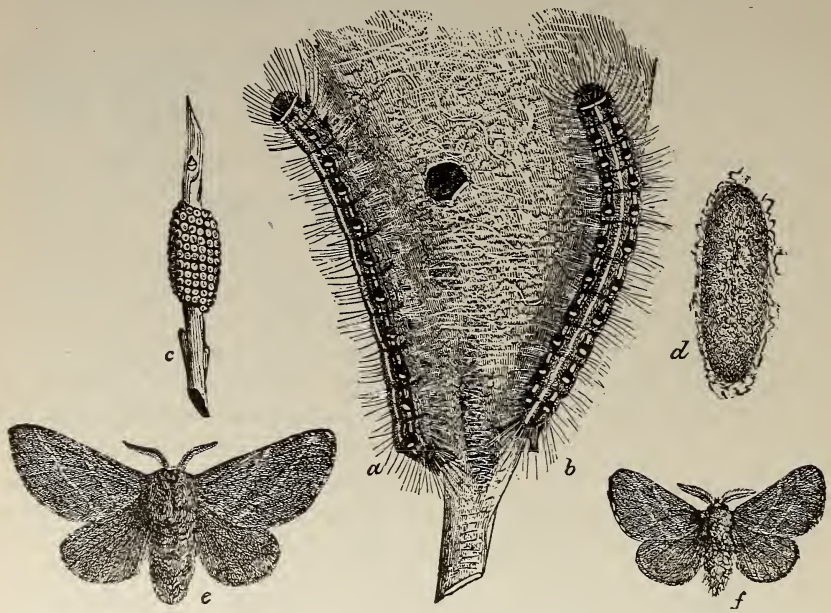

FIG. 29.—Orchard tent-caterpillar (*Malacosoma americana*). (From Riley, Bureau of Entomology.)

food. It is evident that neither hairs nor even pricking, stinging spines are adequate to protect a caterpillar from a hungry grosbeak.

Besides Hymenoptera, Coleoptera, and Lepidoptera, which have been discussed in the order named, but one group of insects of importance in the dietary of the rosebreast remains, that of true bugs (Hemiptera), including the stink bugs, tree hoppers, plant lice, and scale insects. From this miscellaneous assemblage the grosbeak selects 3.89 per cent of its food, and two-thirds of this amount consists of the minute pests known as scale insects. From an economic standpoint also the latter are of greatest importance, as they rank among the worst enemies of agriculture in the United States. Orchards, both of the deciduous and citrus

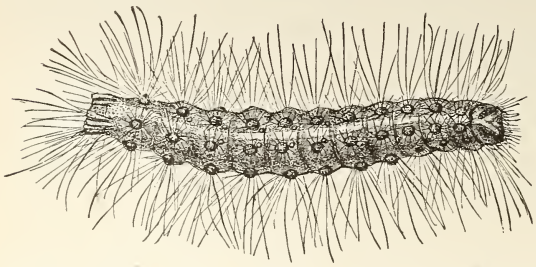

FIG. 30.—Gipsy moth caterpillar (*Porthetria dispar*). (From Bureau of Entomology.)

fruits, are most seriously affected, while shade and forest trees also suffer greatly.

Thirty-three of the rosebreasts examined had eaten scale insects, four kinds of which were identified. The plum scale (*Eulecanium cerasifex*), which is an occasional pest on cherry, apple, and pear, besides the tree from which it is named, seems to be relished. A female grosbeak collected in Indiana in May had consumed 36 plum scales, which constituted 95 percent of its food. Of two birds from Illinois, one ate 45 and the other more than 100 scales of this species, which composed 95 and 100 percent, respectively, of their stomach contents. Two nearly related species, the hickory scale (*E. caryæ*) and the tulip scale (*E. tulipiferæ*), which latter sometimes seriously

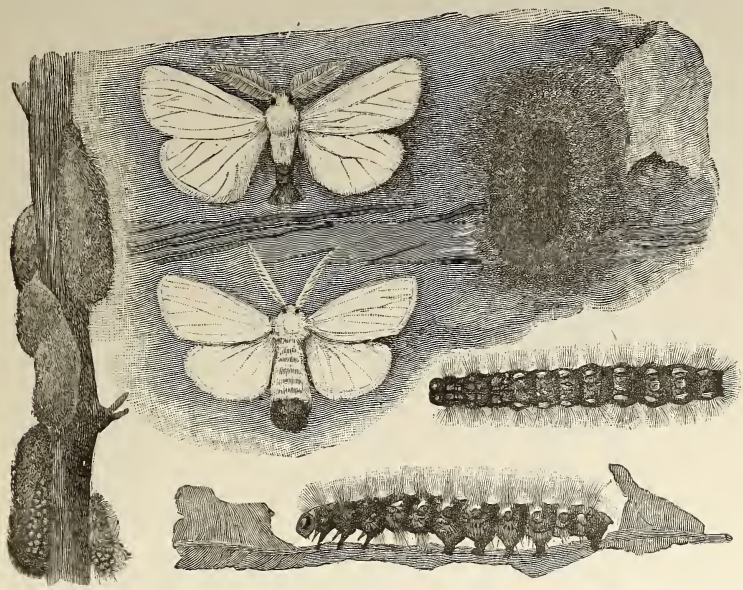

FIG. 31.—Brown-tail moth (*Euproctis chrysorrhoea*). (From Howard, Bureau of Entomology.)

injures shade trees, also are devoured. Eleven grosbeaks ate unidentified species of the same genus of scale insects; two preyed upon the oak scale (*Kermes*), while the stomachs of 15 birds contained scale remains which defied determination.

The fact that birds exert a restrictive influence upon scales has remained almost unknown, these small insects being considered well protected from feathered enemies by their minute size and waxy secretions. Hence little attention has been paid to the subject, and the accounts of a few writers who announced the true relations of birds to scales were overlooked or ignored. Recent investigations have shown that many of our birds eat scales. The rose-breasted grosbeak is prominent among them, both because it eats a maximum num-

ber of species and because at times it makes scales a considerable part of its fare. These little pests can not have too many enemies for the good of mankind, and every bird that preys upon them should be welcomed and protected.

The rosebreast sometimes feeds upon plant lice (Aphididæ), especially those that live on birch; and a number of these fragile insects were found in a single stomach. Among other bugs, the odd little buffalo tree-hopper (*Ceresa bubalus*, fig. 32), and a few of the flower-bug and squash-bug families were found. Eight grosbeaks ate members of the stink-bug family. In feeding upon these insects the rosebreast gives further evidence of its indifference to flavors and odors which to us are repulsive and nauseating in the extreme. Two of the birds examined had devoured specimens of the banded soldier bug

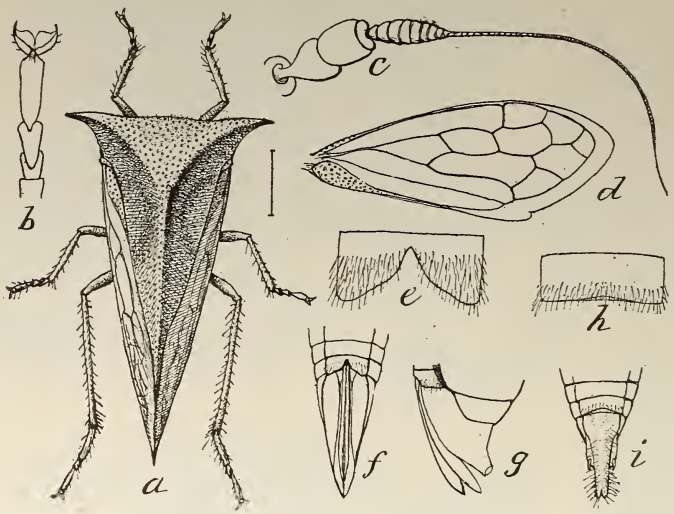

FIG. 32.—Buffalo tree-hopper (*Ceresa bubalus*). (From Marlatt, Bureau of Entomology.)

(*Milyas cinctus*), which preys upon many insects, including the potato beetle, and of another assassin bug (*Sinea diadema*), which preys upon cankerworms and other caterpillars, besides flies and bees, including the honey bee. Were the habit of devouring such bugs general, injury would result, but fortunately it is not. According to B. F. Gault, the rosebreast feeds upon the chinch bug, which at times has proved the worst crop pest in the country.

A remarkable feature of the rosebreast's dietary is the few grasshoppers eaten. These nutritious insects, which are welcomed by almost all birds, compose only 0.2 percent of the food of the whole number of grosbeaks examined. Results from the present collection of stomachs may not represent a fair average, but as proportionate numbers of the individuals examined were secured in the grass-

hopper season the data indicates at least a well-defined tendency of the bird to neglect them. That it does not actually dislike grasshoppers there is sufficient proof, for John Bachman wrote to Audubon [a] that a caged specimen "ate grasshoppers and crickets with peculiar relish," and Samuel Aughey [b] examined two specimens collected during one of the historic invasions of the Rocky Mountain locust, each of which "had about a dozen of locusts in its stomach."

Comparatively little weight, however, attaches to these instances, since the conditions were unusual. It is worthy of note that the closely related blackheaded grosbeak similarly neglects grasshoppers. Four rosebreasts fed upon this class of insects, 2 securing the peculiar shield-back grasshoppers, in one case to the number of 6, which composed 85 percent of the stomach contents, while the other 2 birds had eaten an ordinary grasshopper and an orthopterous insect not identified.

The small quantity of animal matter not yet detailed comprises spiders and their egg-sacs, which were eaten by 3 grosbeaks, and insect eggs and a fly by 1 each. Only 1 bird of this species had eaten a snail, which indicates that the rosebreast cares less for this kind of food than does the cardinal.

Mineral Matter.

Mineral matter, estimated in relation to the entire stomach contents, averaged 6.3 percent. Besides the ordinary sand and fine gravel, fragments of fossil corals and crinoids had been utilized for grinding material.

Nestlings.

Of the total number of birds only 4 were young still being fed by their parents, but, as usual among species whose diet is mixed, the proportion of animal food to vegetable is much greater in the case of fledglings than of adults. These 4 young rosebreasts consumed 78 per cent of animal and 22 per cent of vegetable matter. The 2 that were out of the nest were more highly vegetarian, one having eaten 85 per cent of plant substances. The latter were a berry of rough-leaved dogwood, some blackberries, of which 45 pits were present, and a few other seeds. Of the animal food consumed by the 4 young birds, caterpillars compose 20 percent, among them being the larvæ of sphinx moths, most of which are injurious to agriculture. Almost 25 percent is composed of beetles of various families, including bronzy wood-borers, click-beetles, and leaf-beetles. Representing the last family are the species *Melasoma lapponica*, which injures willow and cottonwood windbreaks, and that noted pest the

[a] Audubon, J. J., Birds of America, III, 1841, p. 211.

[b] First Ann. Rept. U. S. Ent. Comm., 1878, App. II, p. 32.

Colorado potato beetle. Two stomachs of nestlings contained this latter nauseous insect, larvæ being found in one, adults in another. Wasps composed almost half of the food of one fledgling, and a weevil and some small cocoons constituted the remaining animal matter.

Passing from these results of actual stomach examination to the experiences of observers, it should be noted that the rosebreast's habit of feeding its nestlings the larvæ of the potato beetle is frequently recorded. This fact is one of the best evidences of the importance of this beetle in the grosbeak's regimen. Prof. F. E. L. Beal[a] speaks of "a small potato field, which earlier in the season was so badly infested * * * that the vines were completely riddled. The grosbeaks visited the field every day, and finally brought their fledged young. The young birds stood in a row on the topmost rail of the fence and were fed with the beetles which their parents gathered." Prof. E. F. Hitchings, State entomologist of Maine, gives the following interesting note:

> Several years ago I observed a pair nesting in a clump of trees in * * * Waterville. A piece of potatoes was planted near by, and I watched the parent birds as they fed their young on the larvæ of the Colorado potato beetle. I examined the bills of the young and found them stained and even dripping with the juice of the insects. It took a great many young larvæ to satisfy them. (May 19, 1906.)

When we reflect that every year there are thousands of grosbeak families throughout the breeding range of the species doing exactly the same thing, it can not be doubted that they exert a marked effect on the numbers of the potato beetle.

The voracity of nestlings is proverbial, and their lusty appetites greatly enhance their value as destroyers of injurious insects. The number of insects eaten daily by nestlings has been recorded in the case of but few birds; hence we are fortunate in having E. H. Forbush's account of a study of the nestlings of the rosebreast:

> On June 12, 1899, Mr. Mosher watched the nest of a pair of rose-breasted grosbeaks from early morning to 5 p. m. * * * For the first half hour the old birds were so excited by his presence that the feeding of the young birds was interrupted, so that no notes were taken until 6 a. m., and none were taken after 5 p. m. The old birds visited the nest—

	Times.		Times.
Between 6 and 7	52	Between 12 and 1	32
Between 7 and 8	47	Between 1 and 2	38
Between 8 and 9	43	Between 2 and 3	41
Between 9 and 10	30	Between 3 and 4	22
Between 10 and 11	36	Between 4 and 5	58
Between 11 and 12	27		

> making altogether 426 visits during the portion of the day that they were watched. The food was mainly caterpillars of one kind or another, and there

[a] Farmers' Bull. 54, 1904, p. 35.

were only four visits made by a parent bird when but one insect was fed to the young; they usually brought three or more. A bird often carries in this way from three to eleven or twelve small caterpillars in its mouth and beak at one time. Owing to the height of the nest above the ground, it was impossible to determine accurately the species of caterpillars brought to the young. A considerable portion of them were certainly leaf-rollers from the oak trees. It seems probable, then, that these two birds must have fed their young on that day at least 1,000 insects, mostly caterpillars. This certainly is a very moderate estimate of the number of insects destroyed in one day by the family when we take into consideration the food required by the old birds.[a]

Although in this particular instance the precise nature of the food was not ascertained, there is much evidence to show that the same pests are fed to the young which are eaten by adults.

Summary.

Examinations of 176 stomachs of rose-breasted grosbeaks show that the food is composed of animal and vegetable matter in almost equal parts, the exact proportions being 52 and 48 percent, respectively. Of the portion of the diet gleaned from the plant kingdom, 5.09 percent is grain, 1.37 garden peas, and 19.3 wild fruit. A third of the grain eaten may possibly be pillaged from standing crops, but this is the only stage when injury by birds is not easily prevented. Even if the total amount of grain consumed is pilfered from cultivated fields, it does not warrant hostile acts against a bird otherwise so beneficial.

Wild fruit is greatly relished, but cultivated fruit is not damaged, and although budding is practiced to a certain degree practically no harm results.

The rosebreast preys to some extent upon such beneficial insects as parasitic Hymenoptera, ground beetles, ladybirds, and fireflies. Only a tenth of the animal food is of this character, however, while among the remaining nine-tenths, which consists almost exclusively of injurious insects, is included a large number of formidable pests. Among these are the cucumber beetles, the hickory borer, plum curculio, Colorado potato beetle, Rocky Mountain locust, spring and fall cankerworms, orchard and forest tent-caterpillars, tussock moth, army worm, gipsy and brown-tailed moths, and the chinch bug. The bird is known as an active enemy of the cankerworm and the army worm during their extraordinary infestations, and was among the birds which preyed upon the Rocky Mountain locust and the gipsy moth at the height of their destructiveness.

Few birds have so good record both as to the large number of important pests attacked and the slight amount of damage done.

[a] Forty-seventh Annual Report Mass. State Board of Agriculture (1899) 1901, p. 325.

LIST OF SEEDS, FRUITS, OTHER VEGETABLE SUBSTANCES, AND INVERTEBRATES EATEN BY THE ROSE-BREASTED GROSBEAK.

CULTIVATED PLANTS.

Corn (*Zea mays*).
Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).
Cherry (*Prunus cerasus*).
Peas (*Pisum sativum*).

WILD FRUITS.

Mulberry (*Morus rubra*).
Pokeberry (*Phytolacca decandra*).
Sweet gum (*Liquidambar styraciflua*).
Blackberry (*Rubus* sp.).
Strawberry (*Fragaria* sp.).
Juneberry (*Amelanchier canadensis*).
Red haw (*Crataegus* sp.).
Wild red cherry (*Prunus pennsylvanica*).
Choke cherry (*Prunus virginiana*).
Wild black cherry (*Prunus serotina*).
Redbud (*Cercis canadensis*).
Supple-jack (*Berchemia scandens*).
Rough-leaved cornel (*Cornus asperifolia*).
Checkerberry (*Gaultheria procumbens*).
Nightshade (*Solanum* sp.).
Sweet elder (*Sambucus canadensis*).
Red-berried elder (*Sambucus pubens*).

BUDS AND FLOWERS.

Cottonwood (*Populus* sp.).
Post oak (*Quercus minor*).

WEEDS.

Green foxtail (*Chætochloa viridis*).
Sedge (*Carex* sp.).
Knotgrass (*Polygonum aviculare*).
Pale persicaria (*Polygonum lapathifolium*).
Pennsylvania persicaria (*Polygonum pennsylvanicum*).
Black bindweed (*Polygonum convolvulus*).
Dock (*Rumex* sp.).
Pigweed (*Amaranthus* sp.).
Bloodroot (*Sanguinaria canadensis*).
Wild radish (*Raphanus sativus*).
Touch-me-not (*Impatiens biflora*).
Dodder (*Cuscuta* sp.).
Blue vervain (*Verbena hastata*).
Giant ragweed (*Ambrosia trifida*).

COLEOPTERA.

Ground-beetles (Carabidæ):
Pasimachus depressus.
Ladybirds (Coccinellidæ):
Chilocorus bivulnerus.
Brachyacantha ursina.
Histeridæ:
Hister sp.
Nitidulidæ:
Ips fasciatus.
Click-beetles (Elateridæ).
Bronzy wood-borers (Buprestidæ):
Chalcophora virginiensis.
Dicerca obscura.
Fireflies (Lampyridæ):
Ellychnia corrusca.
Photinus pyralis.
Podabrus tomentosus.
Telephorus bilineatus.
Telephorus carolinus.
Telephorus rotundicollis.
Lamellicorn beetles (Scarabæidæ):
Aphodius fimetarius.
Aphodius granarius.
Aphodius inquinatus.
Dichelonycha elongata.
Lachnosterna sp.

COLEOPTERA—continued.

Lamellicorn beetles—Continued.
Cotalpa lanigera.
Euphoria fulgida.
Long-horned beetles (Cerambycidæ):
Phymatodes varius.
Cyllene pictus.
Leptura sp.
Leaf-beetles (Chrysomelidæ):
Orsodachna atra.
Cryptocephalus 4-maculatus.
Griburius equestris.
Typophorus canellus.
Nodonota tristis.
Leptinotarsa decemlineata.
Chrysomela sp.
Calligrapha bigsbyana.
Calligrapha philadelphica.
Melasoma lapponica.
Diabrotica 12-punctata.
Leaf-beetles—Continued.
Diabrotica vittata.
Odontota dorsalis.
Odontota nervosa.
Scarred snout-beetles (Otiorhynchidæ).
True snout-beetles (Curculionidæ):
Sitones sp.
Phytonomus sp.
Hylobius pales.
Conotrachelus albicinctus.
Conotrachelus juglandis.
Conotrachelus nenuphar.
Ampeloglypter sesostris.
Balaninus nasicus.
Brenthidæ:
Eupsalis minuta.
Bill-bugs (Calandridæ):
Rhodobænus 13-punctatus.

HEMIPTERA.

Tree-hoppers (Membracidæ):
Ceresa bubalus.
Scale insects (Coccidæ):
Kermes sp.
Eulecanium caryæ.
Eulecanium cerasifex.
Eulecanium tulipiferæ.
Plant lice (Aphididæ).
Stink bugs (Pentatomidæ).
Coreidæ.
Plant bugs (Capsidæ).
Assassin bugs (Reduviidæ):
Sinea diadema.
Milyas cinctus.

ORTHOPTERA.

Short-horned grasshoppers (Acridiidæ):
Tettix sp.

LEPIDOPTERA.

Hawk moths (Sphingidæ).
Owlet moths Noctuidæ):
Heliophila unipuncta.
Span worms (Geometridæ):
Paleacrita vernata.

HYMENOPTERA.

Short-tongued bees (Andrenidæ).
Cuckoo-flies (Chrysididæ):
Chrysis sp.
Smooth-headed ants (Formicidæ):
Camponotus sp.
Saw-flies (Tenthredinidæ).

OTHER INSECTS.

Two-winged flies (Diptera).

OTHER INVERTEBRATES.

Spiders (Araneida).
Snails (Gastropoda).

BLACK-HEADED GROSBEAK.

(*Zamelodia melanocephala.* Plate III.)

APPEARANCE, DISTRIBUTION, AND HABITS.

In form and size the black-headed grosbeak is almost a counterpart of the last species, but it is very different in color. In the male blackhead, golden brown and lemon yellow take the place of the rose and white of the rosebreast; while the color of the underparts of the female is not soiled white, as in the eastern bird, but bright buffy. Both sexes of the western grosbeak have a horn-colored beak; that of the rosebreast is white.

Occupying a range from the west coast eastward which is complementary to, although slightly overlapping that of its eastern relative, the blackhead occurs from lowermost Mexico to southern British Columbia, northern Montana, western North Dakota, and northeastern Nebraska. It breeds at both extremes, and withdraws in winter to the southern third of its range, lingering as far north, however, as central Mexico.

The male is a brilliant songster, the peer of any of his kin. He is also an excellent mate and parent, and assumes an equal share of the labors of the nesting season. The nests of this species are loosely built and generally are placed in low growth, often along streams. The eggs are 3 or 4 in number and are similar to those of the rosebreast. The young are hatched in May and June. Since the bird often makes its home in higher altitudes it is sometimes called the mountain grosbeak.

ECONOMIC RELATIONS.

So great is the economic importance of the black-headed grosbeak that partial accounts of its food habits appear in two previous publications of the Biological Survey.[a] Only 70 stomachs were then available for examination, while more than three times that number[b] are now at hand, collected in five States and Territories. As the greater number are from California, the present report relates essentially to that State. The stomachs were collected from April to August, inclusive. The data show that about two-thirds of the bird's food consists of insects and other animal matter and one-third of vegetable substances. To be more exact, 65.85 percent is animal, 34.15 vegetable. The maximum amount (79.95) of animal matter is consumed in June. From the standpoint of the agriculturist great interest attaches to the vegetable food of this bird, as it is reputed to be destructive to cultivated fruit.

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[a] Farmers' Bull. 54, 1904, pp. 35–36; Yearbook Dept. Agr., 1904, pp. 246 and 248.

[b] About half of the total number of stomachs of this species were examined by Prof. F. E. L. Beal.

VEGETABLE FOOD.

Wheat and oats constitute but 2.08 and 1.83 percent, respectively, of the total food. Weed seeds and miscellaneous vegetable matter make up 9.28 percent, while fruit exceeds the sum of all these elements, and amounts to 20.96 percent of the entire subsistence, or almost two-thirds of the vegetable portion of the food. Fruit as an item of the bird's food assumes all the more importance because much of it is cultivated.

FRUIT.

Cultivated fruit that can be positively identified averages 9.85 percent of the contents of the 226 stomachs examined, and wild species 6.37 percent. In addition, 2.02 percent consisted of blackberries and raspberries, which may have been either wild or cultivated; 2.72 percent was undetermined fruit pulp of equally doubtful economic significance. It seems certain, therefore, that considerably more than half, perhaps two-thirds, of the fruit consumed by black-headed grosbeaks is from orchards and gardens. As this may be taken from a restricted region in a limited time, the item is of considerable importance in any locality where grosbeaks are numerous.

Moreover, no fruit, however large and tough-skinned, is proof against the massive beak of the blackhead, and the bird is likely to damage a great deal more than it eats because of its habit of leaving fruits after it has taken a single bite. Indeed, many of the fruits it attacks are so large that the bird could not swallow them entire. Apples, crabapples, peaches, apricots, pears, figs, plums, cherries, gooseberries, and blackberries are included in complaints of injury which have been received by the Survey and prunes and strawberries must be added to the number on the evidence of stomach examinations.

According to Professor Beal,[a] in California the depredations by the black-headed grosbeak cause it to be ranked about fourth in importance among fruit-eating birds. What this means will be better understood from account of the actual damage by the species. Prof. A. J. Cook gives the following instance:[b]

> A cherry grower at Ontario, Cal., reports the loss of half of a $4,000 crop of cherries from the depredations of birds in 1898. The birds in order of importance are *Piranga ludoviciana*, *Phainopepla nitens*, and the present species.

E. W. Nelson, of the Biological Survey, writes concerning his acquaintance with this grosbeak at Nevada City, Cal.:[c]

> I was told they were a great pest to fruit growers as they ate and destroyed a great many berries. This I proved by shooting several with their bills stained

[a] Yearbook Department of Agriculture 1904, p. 246.
[b] California Cultivator, Aug., 1898, p. 253.
[c] Proc. Bost. Soc. Nat. Hist., 17, 1875, p. 359.

with blackberries and their crops full of them. I saw many of the berries which they had taken one bite from, leaving the rest.

In New Mexico the bird bears no better reputation, according to Jackson Tabor, of Folsom, who says:

I have found the black-headed grosbeak to be very destructive to all kinds of vegetables and fruits. They made their first appearance in this country in the year 1888, and they came in swarms. * * * They destroyed the entire crop of gooseberries and commenced on crabapples, eating the apples off the top of the tree as I was picking them off the lower limbs. In the spring and early summer they take the cherries as fast as they get ripe, and the only remedy seems to be to wage a war of extermination against them. (September 2, 1903.)

Two stomachs were collected in Mr. Tabor's orchard on this date and both contained fruit, that in one stomach being identified as crabapple.

Following are the results obtained from the investigation of stomach contents: Cherries, both ripe and green, were selected by 41 of the grosbeaks examined, frequently composing from 45 to 95 percent of the stomach contents. All were identified by skins, not a seed being found, showing that the birds here and there bite into a cherry, destroying in this way many more cherries than if they satisfied their appetites by swallowing the fruit entire. Figs were next in order of preference, being devoured by 23 grosbeaks. In some cases they composed from 80 to 100 percent of the food. Among other fruits, remains of plums, crabapples, and apricots were found, each in one stomach, and strawberries in two. Unidentified fruit pulp and blackberries had been eaten by 23 birds. As noted above, it is uncertain whether these were cultivated or not, but probably the bulk were cultivated and should be charged against the bird.

Thus far our investigations have revealed nothing but injury by the bird, but, as will be shown later, the blackhead is not exclusively an enemy.

Protective methods.—In connection with this subject there remains to be considered possible methods of reducing or altogether preventing loss from depredations by these birds. The plan usually suggested is the one mentioned in the above letter of Mr. Tabor, namely, "a war of extermination." This is generally effected by poisoning or shooting.

Aside from the fact that the justice of this method is open to serious question, there is the greater objection that innocent species often suffer equally with or even in greater degree than the marauder. In illustration we quote from Frank Stephens:[a]

At Beale Spring both sexes were common and destroying quantities of fruit, to the great annoyance of the owner of the orchard, who employed an

[a] Condor, V, 1903, p. 103.

Indian to shoot the birds. Unfortunately the Indian did not discriminate between the noxious and harmless species.

When poisoning is resorted to as a means of defence the destruction of many beneficial birds is inevitable. Nevertheless, if the above methods are condemned the fruit grower is entitled to ask for an effective substitute. A device for the protection of a small number of trees, which can be applied on rather short notice, is bird netting. This was tested upon cherry trees some years ago at the Indiana Agricultural Experiment Station.[a] The netting was procured at a cost of 4 cents per square yard and 75 yards were required per tree, the latter having been set six years. The fruit produced in a single season paid for the netting, which with careful handling, it is said, will last for ten years or more. This method is practicable in the case of a few lawn or garden trees, or possibly even in small orchards, and is well worth trial by anyone who considers future as well as present fruit crops. For it is certain that in destroying grosbeaks we end the lives of creatures which do much to check serious insect enemies of fruit. In large orchards netting of course can not be used.

Killing the grosbeaks is a last resort to be tried only when every other measure has been tested and failed. It is the less excusable because a method is available which, even in the case of large orchards, yields far better results. This is the planting here and there of wild fruit-bearing trees and shrubs, by means of which almost complete protection to cultivated fruit can be assured.

The chief essential is that the decoy trees shall be early bearing species, for it is the universal testimony that almost all of the damage done is to early fruit. How this applies in California is made clear in the following account of Professor Beal's experience in Alameda County. In the numerous orchards in Cull's Canyon only one grosbeak was seen where a week before, the last few days in May, they were common. It was a fine illustration of what has been demonstrated before—that the first fruits are the ones most eagerly eaten by the birds. When the early cherries were ripening in the orchard birds were to be seen on all sides—grosbeaks, orioles, tanagers, linnets, and jays, with now and then a blackbird or a flicker; but in June only one grosbeak and a few jays were seen, though the later cherries were just in perfection and nobody was disturbing the birds. A natural question is: Why are the later fruits comparatively immune to the attacks of birds? It may be urged that the feathered robbers get enough, that their appetites flag. While perhaps true of some birds, satiety in no way explains the facts concerning the black-headed grosbeak, since this bird consumes twice as much fruit in July and August as in May, though the quantity secured from cultivated

[a] Troop, James, Bull. 53, Dec., 1894, pp. 125–126.

sources is much less. It is evident that wild fruits are preferred, and that it is their abundance that protects the later ripening orchard varieties. In order to protect early cultivated fruit, therefore, it is necessary to plant decoy fruit trees which will come into bearing at the same time as the earliest varieties.

Such a fruit is the mulberry, which has long been known as a favorite of all frugivorous birds. There are many varieties derived from both foreign and native species, some one or other of which is suitable for any part of the United States. Perhaps the best of these to protect early fruit is the Townsend, which originated in northern Florida from the native red mulberry. This mulberry is very prolific and ripens fruit very early (in the latter part of March and April in Florida), a characteristic it will doubtless retain wherever it may be planted. Among other races of the same native stock are the Hicks, bearing in June and July, and the Stubbs, from June to August. The white mulberry of Asia (*Morus alba*) has yielded the Black English, the season of which is May to July, and the New American, fruiting at the same time, but very hardy, being adapted to mountain climates. The Russian mulberry (*Morus a. tatarica*) also is hardy, and bears in May and June. The suitability of the mulberry for California is affirmed by Prof. E. J. Wickson,[a] who says: "Nearly all varieties of the mulberry have been introduced in California and grown rapidly and thriftily." He commends the New American and Russian, mentioned above, and further states: "The mulberry has a long season. The Persian ripens in Tulare the last of May and continually thereafter until October."

Although the mulberry is an excellent fruit when fresh, it has been put to little use, the main reason no doubt being that it is not adapted to transportation. Since it is not of commercial importance, why not use it to protect more valuable fruits? The returns from such an investment, according to the testimony of many observers, are great. Dr. C. Hart Merriam says:[b]

> Groves of mulberry trees during the period of fruiting are thronged by hundreds if not thousands of birds, comprising many species and representing diverse groups. Such insectivorous kinds as flycatchers, warblers, vireos, and even cuckoos, form a part of the heterogeneous assemblage, departing from their customary diet long enough to join the multitude of blackbirds, orioles, finches, sparrows, tanagers, waxwings, catbirds, bluebirds, and thrushes, which from daylight until dark gorge themselves upon the tender berries. It seems incredible that such small birds as warblers, vireos, and the least flycatcher can open their tiny mouths wide enough to swallow such large berries as they really do gulp down with little effort. I know of no better tree than the mulberry to plant in public and private grounds for the purpose of attracting our resident birds.

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[a] California Fruits and How to Grow Them, San Francisco, 3rd ed., 1900, p. 398.

[b] Rept. Chief Div. Ornith. and Mamm. (1890), 1891, p. 285.

Further evidence of the attractive qualities of the mulberry is given by Dr. A. K. Fisher, who states that at his home in southern New York, a dark fruited, juicy Russian mulberry was a favorite food of a number of birds. Robins, catbirds, cedar birds, orioles, and to a less extent several other fruit-eating birds, fed by preference on mulberries, and rarely attacked cultivated cherries, which were abundant. In fact, as the period of mulberry ripening extended beyond the time of cherry harvesting, the more valuable fruit was almost completely protected from the depredations of birds.

The efficacy of the mulberry as a protection to cultivated fruits is fully confirmed also in a bulletin of the North Carolina Agricultural Experiment Station, which is exclusively devoted to the subject of mulberries:[a]

> They serve an excellent purpose near cherry trees and on strawberry plantations in attracting birds away from these fruits. As long as there are ripe mulberries close at hand, the other fruit will suffer very little from birds.

Such being the case, the several varieties of mulberries, on account of their great fruitfulness and the long bearing season, are well adapted to the protection of a wide range of fruit crops, including many of the later as well as the earlier ripening fruits.

Among other species valuable for the same purpose are certain inedible cherries. Mr. H. W. Henshaw informs the writer that a single tree of small sour cherries afforded almost complete protection to several trees of very fine cultivated cherries on the place of Mr. Joseph Palmer, near Washington. At the time a visit was made to this place, catbirds, robins, and orioles were abundant, and surprise was expressed that the crop of cherries was not molested. Pointing out a volunteer cherry tree, Mr. Palmer said: "There you see the reason; the birds will not touch the large cultivated cherries when the small ones are to be had."

Examination of this tree was made during the present year (1907). It proves to be the Mahaleb or Saint Lucie cherry (*Prunus mahaleb*). The 1907 crop of all kinds of cherries was very small, but as far as could be determined under the circumstances, the Mahalebs were preferred. In five minutes the writer noted in this tree 2 brown thrashers, 1 jay, 1 bluebird, 1 cedar bird, 1 kingbird, and 3 catbirds. All ate the fruit greedily. It appears that the birds must have cherries, though not the best varieties necessarily. Hence some such species as the Mahaleb is likely to afford more efficient protection than any other kind of fruit. It ripens with the cultivated cherries in this latitude and is very prolific, and since it is extensively imported for grafting stock it should be obtainable at low rates. The European bird

[a] H. Hume and F. C. Reimer, No. 194, 1906, p. 56.

cherry (*Prunus padus*), a most beautiful ornamental plant, also maturing fruit early, may be used to supplement the Mahaleb.

Other available trees and shrubs are juneberries, which fruit early, elderberries and blackberries for the summer, and a host, including native wild cherries, black and red haws, sumacs, and wild grapes, for the fall.

It may be objected by the orchardist that equal protection can be secured and, in addition, a saving of space be effected by simply increasing the number of fruit trees to allow for the loss by birds. It is doubtful, however, if this method would yield equivalent protection, since the injury would be widely distributed and some fruit spoiled on every tree; whereas decoy trees bearing the natural wild food of the birds will prove centers of attraction, and if they do not furnish enough fruit to satisfy the birds, the damage to the crop will be confined to a small number of trees in their immediate vicinity.

In this connection, in order to determine which are the best fruits to plant to draw the attention of the black-headed grosbeak, it is logical to consult the bird's own taste. We find elderberries far and away in the lead, they are eaten by a ninth of the whole number of birds examined and often compose from 70 to 100 percent of the stomach contents. Next in importance are blackberries, which have been discussed, and following these, juneberries (Pl. II, fig. 3), mulberries, and sumac fruits take equal rank. The bird is known to be fond also of the northwest black haw (*Cratægus douglasi*). It appears from the above facts that elderberries, juneberries, and mulberries are the most serviceable for diverting the attacks of the black-headed grosbeak from cultivated fruits.

In concluding this part of the subject it should be noted that although fruit is such a favorite food with the grosbeak, it constitutes only a limited part of the bird's diet, and that more than three times its bulk in injurious insects is eaten. Furthermore, the equivalent of three-fourths the amount of fruit is composed of other classes of vegetable matter, including weeds and grain.

GRAIN.

As has been stated above, wheat averages 2.08 percent of the stomach contents of the birds examined, and oats 1.83 percent. They were consumed by 8 and 10 grosbeaks, respectively. The bird rarely has been accused of injuring either grain, but we have a bit of testimony regarding its fondness for oats. Mr. S. H. Goodwin,[a] referring to newly sown fields in Utah, states:

> I have seen these birds in oat fields again and again, and have found them fairly stuffed with oats. But at most the damage is slight, for the birds are not sufficiently numerous to make them a serious factor in this direction, and the services rendered are many.

[a] Deseret Farmer, III, 1907, No. 27, p. 8.

Oats may be injured later in the season when in the milk, as some were found in the stomach of a nestling blackhead. This grain, however, may have come from the abundant wild oats. In any case, the small percentage of grain consumed precludes serious injury under all but the most exceptional conditions.

WEED SEED AND OTHER VEGETABLE FOOD.

From April to August, inclusive, weed seeds constitute an average of 8.74 percent of the food of the blackheaded grosbeak. Most of the seeds are derived from noxious plants; hence their destruction is a service. Alfilaria (*Erodium*) seeds were taken by 13 birds, and chickweed (*Alsine*) by the same number. The little shining black seeds of red maids (*Calandrinia*) were eaten by 8 individuals, and the large fleshy akenes of the milk thistle (*Mariana*, Pl. II, fig. 12) by 5. Professor Beal several times has observed blackheads feeding on the latter seeds, and the birds are known to be quite fond also of the similar seeds of the garden sunflower. Among other weed seeds found in the stomachs are tumbleweed (*Amaranthus*, fig. 18), smartweed (*Polygonum*, fig. 1), dock (*Rumex*), nightshade (*Solanum*), catchfly (*Silene*), geranium, and bur clover (*Medicago*).

A few miscellaneous things, such as spires and wads of grass, coniferous leaves, and galls, were present in a few stomachs.

Several items not detected in the stomachs examined are mentioned by other writers, and among them are garden peas, which it will be remembered are relished by the rosebreast also. Dr. J. A. Allen[a] wrote in 1872 that in Utah the blackhead is "called 'pea bird,' it being very fond of young peas, and is hence regarded as obnoxious."

Mr. Jackson Tabor, of Folsom, N. Mex., in connection with his description of the bird's depredations on fruit says:

> They commenced on early vegetables, took the pea crop in toto, and put in their work on everything in the garden, even eating green beans that I never knew anything else to touch. (September 2, 1903.)

The bird shares in a taste said by many to be characteristic of all grosbeaks, and Mr. Henshaw[b] in 1876, writing of the bird's habits in the middle region of the West, states that—

> It appears especially fond of the buds of various deciduous trees and plants, and the bills of many of those taken had been stained and gummed with their juices.

At times it feeds extensively on willow buds, according to Doctor Coues, and Mr. Ridgway says that in May, in Truckee Valley, Nevada, it was observed to feed on the buds of the greasewood.[c]

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[a] Bull. M. C. Z., III, 6, 1872, p. 168.

[b] Zool. Expl. West of 100th Meridian, V, 1876, p. 297.

[c] Geol. Expl. 40th Parallel, IV, Pt. III, 1877, p. 488.

Animal Food.

Insects and other animal matter eaten by the black-headed grosbeak amount to almost twice the bulk of the vegetable food, or 65.85 percent of the total subsistence. These, then, should be regarded as the really staple foods of the species. While no single vegetable element was fed upon by more than 41 grosbeaks, certain items of the insect diet were chosen by more than a hundred, or over half of the birds examined. This fact suggests that if the majority of the insects preyed upon are noxious, the benefits conferred by the bird greatly outweighs the injury inflicted.

Coming, then, to the economic status of the insects devoured, it appears from the results of the examination of 226 stomachs that 3.37 percent of the bird's food consists of ground beetles, fireflies, and ladybirds, which usually are considered beneficial; 2.56 percent is composed of wasps, ants, bees, etc., some of which are very useful, some innocuous or harmful; and 1.17 percent is made up of a great number of unrelated items, largely of neutral import, which, owing to the fact that they are rarely eaten, have little significance. Thus 58.75 percent, or nearly three-fifths of the entire food, is composed almost wholly of insects which are a constant menace to agriculture.

Of the above classes the beneficial kinds deserve first consideration. The most important among them numerically are fireflies (Lampyridæ), which are almost uniformly carnivorous, both as larvæ and as adults. Since they do much to check the increase of many other insects, the destruction of large numbers would be injurious. Fifty-two of the grosbeaks examined had fed upon fireflies to the extent of 2.38 percent of the whole food. Both adults and larvæ were captured, from 5 to 19 of the former and from 12 to 30 of the latter being found in some stomachs.

Among other useful insects which are attacked by the blackhead are the ground beetles (Carabidæ). Nineteen grosbeaks ate them, and they amount to 0.99 percent of the food. Since so few of these beetles are captured and as certain of them at times feed upon plants, the injury is too slight to be noticed.

Three black-headed grosbeaks ate small ladybird beetles which prey upon scale insects and plant lice, two of them securing specimens of an Australian coccinellid (*Rhizobius ventralis*, fig. 33), which was introduced into California for the express purpose of destroying scale insects. If the grosbeak destroyed many of these beetles, the bird would have to be given a black mark, but when it is considered that the blackhead feeds upon scale insects a large part of the time (more than a fifth of its food consisting of scales), it is surprising that so few of the ladybirds are devoured.

Considerable liking, however, was shown for another group, the Hymenoptera, part of which at least are beneficial. The most useful

members of this order are the parasitic Hymenoptera, which lay their eggs in the eggs or young of other insects. Remains of insects of this class from the stomach of one grosbeak were identified and they amounted to 22 percent of its contents. Two bees were found in another stomach, one of which was a worker honeybee. These are the only beneficial species of Hymenoptera from stomachs of this grosbeak positively identified, but it is probable that many of the unidentified forms belong in the same category. In all, 58 grosbeaks fed upon wasps, bees, and ants, very many of which selected large wasps, which were most probably workers of some social species the loss of which would not be noticed. Eleven blackheads ate ants, including both pupæ and adults, for which the birds are to be commended, as many ants are prejudicial to the interests of man.

Summing up the relations of the black-headed grosbeak to beneficial insects, Hymenoptera constitute 2.56 percent of the food, not all of which, as just noted, is to be set down against the bird. The wholly useful fireflies amount to 2.38 percent, the mainly beneficial ground beetles to about 1 percent, while the ladybirds are a mere trace. Thus only about 5 percent, or a little more, of the bird's food consists of insects the destruction of which is prejudicial to the welfare of man. Even were the bird not useful otherwise, this showing would hardly justify reprisals.

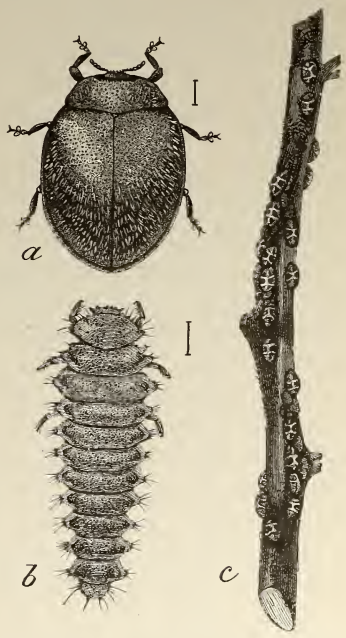

FIG. 33. — An Australian ladybird (*Rhizobius ventralis*). (From Marlatt, Bureau of Entomology.)

As a matter of fact, however, the blackhead is far from useless, since the remainder of the animal food, which is fully 11 times the bulk of the useful insects, consists of pests upon some of which no other bird is known to prey so extensively. Beetles of various families constitute about half the bulk of these harmful insects, and 28.71 percent of the total food. A much greater number of grosbeaks preyed upon leaf beetles (Chrysomelidæ) than any other family, these composing 17.98 per cent of the diet. One hundred and seventy-two blackheads, or almost four-fifths of the total number examined, captured leaf beetles, which are said to include among their ranks more enemies of crops, shade trees, and ornamental plants than any other family of beetles.

While this unmistakable preference for the often pungently flavored Chrysomelidæ is remarkable, it is still more surprising that of the 172 birds 103 selected a single species, the California flower-beetle (*Diabrotica soror*, almost indistinguishable from *D. 12-punctata*, fig. 26). This insect, according to Prof. Vernon L. Kellogg,[a] "does great damage as an adult by eating into the flower buds of roses, chrysanthemums, and a host of others, the larvæ feeding on the roots of alfalfa, chrysanthemums, and many other plants." Prof. E. J. Wickson adds,[b] it "is sometimes very injurious to early fruit by eating into it when ripe. The insect also eats leaves and blossoms. As the insect attacks the fruit just as it is ready to pick, it is impossible to apply any disagreeable or poisonous spray."

In connection with the latter testimony it is of interest to recall that the early fruits are the ones that the bird also injures most severely. Although less than 4 percent of the food, strictly speaking, can be called early fruit, and the total amount of cultivated fruit eaten during the bird's stay in California is only about 12 percent, the fruit-destroying flower-beetle, which it is impossible for man to combat effectually, constitutes more than 14 percent. In view of this fact alone, it would seem that the hand raised with deadly intent against the grosbeak when pilfering fruit may well be stayed. The beetles, though not so easy to see as the grosbeak, are present in countless hordes and busy at their destructive work. But the grosbeak finds and consumes more of them by actual bulk than of cultivated fruit. Furthermore, in view of the fact that 103 out of 226 black-headed grosbeaks preyed upon the flower-beetle, often securing from 8 to 21 each, and that 14.08 percent of the bird's entire food consists of these insects, it can be unhesitatingly stated that the black-head is one of the most important checks upon this pest.

While the grosbeak does not destroy any other insect to anything like the same extent that it does the flower-beetle, nevertheless it shows a considerable liking for some other leaf-beetles. Seventeen grosbeaks fed upon a species (*Melasoma scripta*) that is fond of the foliage of willows and poplars, and 15 devoured a dock-inhabiting leaf-beetle (*Gastroidea*), which sometimes eats pine needles; from 9 to 33 of these were found in a single stomach. About 37 grosbeaks ate leaf-beetles which could not be specifically identified.

The closely related family of long-horned wood-borers (Cerambycidæ) furnishes 2.29 percent of the bird's fare, and since the longicorns contain among their ranks numerous disastrous pests, the bird must be commended even for the moderate liking for them it displays. Click-beetles (Elateridæ), which in the larval state are known as

[a] American Insects, 1905, p. 280.

[b] California Fruits and How to Grow Them, 1900, pp. 454–455.

wireworms, were devoured by 30 black-headed grosbeaks, but constitute only 0.77 percent of the food. Weevils also are sparingly consumed, which is in contrast to the avidity shown for them by most insect-eating birds. Twenty-five of the present collection of blackheads obtained specimens of these queer snouted beetles, but they compose less than 1 percent of the subsistence.

Bronzy wood-borers (Buprestidæ) were captured by 8 grosbeaks, pine-feeding species being identified. Lamellicorn beetles (Scarabæidæ) fell a prey to 10 birds, but no important species were secured. A few blackheads obtained representatives of other coleopterous famlies, such as rove-beetles (Staphylinidæ), darkling beetles (Tenebrionidæ), and whirligig beetles (Gyrinidæ), one of which was found in a single stomach, though how the bird secured this aquatic species is a mystery. A quick tiger-beetle (*Cicindela*) also was found in a single stomach, and hence, although beneficial, it may be passed by without comment.

Coleopterous larvæ were eaten by 7 birds, 2 of which had secured representatives of the family Nitidulidæ. As these larvæ are too minute to have been eaten intentionally, and since they feed on decaying fruit, their presence among the stomach contents shows that the grosbeak also sometimes eats decayed fruit. Some of the fruit pulp, therefore, which could not be identified, but which was provisionally reckoned against the bird, is thus proven to have no value.

Grasshoppers, which are eaten by birds almost universally, are neglected by this species, as they are also by the rose-breasted grosbeak. Only 7 of the 226 blackheads examined had eaten them, and they constitute only 0.25 percent of the subsistence. Nevertheless, the black-headed grosbeak is included among the enemies of the Rocky Mountain locust by Samuel Aughey, who examined 2 specimens, one of which had eaten 8, the other 17 locusts.

Notwithstanding the blackhead is rather whimsical about a grasshopper ration, it shares the taste of most other birds for caterpillars, and it devours them and their chrysalids to the extent of 9 percent of its food. Spines and hairs, popularly supposed to be abhorred by birds, do not deter the blackhead, and sometimes all that is left in the stomach to tell of the capture of caterpillars is a mass of thorns and spines. Exactly 100 black-headed grosbeaks fed upon lepidopterous insects, 70 of them choosing caterpillars and 30 cocoons and chrysalids. It is among remains of the latter that we find representatives of the most important species in the order—the codling moth (fig 34). This pest is said to cause a loss of not less than $10,000,000 annually to the fruit growers of the United States. Inasmuch as the insect has no important parasites, its feathered enemies should be all the more appreciated, and it is safe to say that, with the probable exception of woodpeckers, the blackhead is the equal of any of them.

The codling moth is accessible to the grosbeak in two stages of its development, namely, when the larvæ are seeking a place to hibernate or pupate, as the case may be, and when they are in the chrysalis stage. By no means all of the birds examined had access to the species, yet 25 were successful in finding the pupæ or larvæ, and secured from 1 to 29 individuals, averaging about 5 each. It appears, therefore, that the grosbeak makes good use of its limited opportunities, and we agree with Professor Beal[a] that the "bird that helps to destroy this * * * insect, the curse of * * * apple culture, will be hailed as a blessing in spite of any shortcomings it may have."

Second in importance only to the above pest are cankerworms.

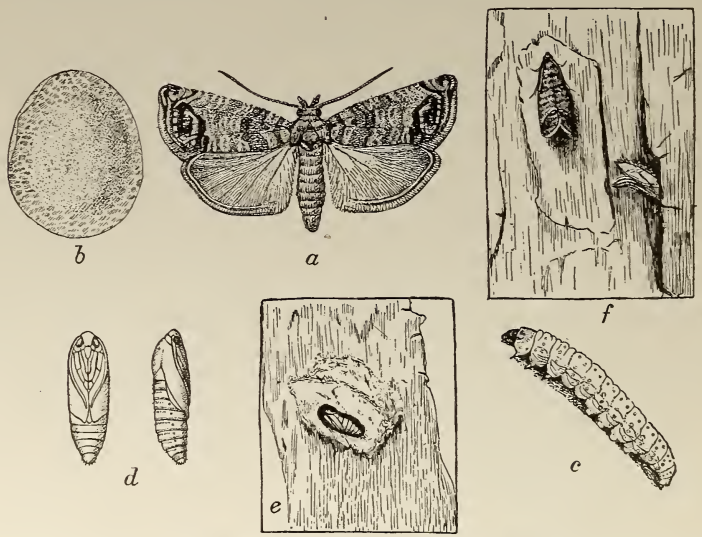

FIG. 34. Codling moth (*Carpocapsa pomonella*). (From Simpson, Bureau of Entomology.)

The spring cankerworm (*Paleacrita vernata*, fig. 35), which is responsible for a great deal of damage in apple orchards, constitutes 6 percent of the grosbeak's food in May. While this amount is not large, it is nevertheless worthy of note, since all of it is consumed when the earliest broods are developing.

Only one other order of insects contributes largely to the subsistence of the black-headed grosbeak—the true bugs, Heteroptera-Homoptera. Among minor items of the order the Heteroptera collectively form 1.05 percent of the diet, plant bugs, together with members of the squash-bug and stink-bug families and unidentified forms, being eaten by 18 birds. A miscellaneous assemblage from

[a] Yearbook Dept. Agr., 1904, p. 248.

the other group (Homoptera), including leaf and tree hoppers, plant lice, and cicadas, was distributed among 9 of the grosbeaks examined, and composes a little more than 0.5 percent of the total food. Next is the family of scale insects (Coccidæ), which from an economic standpoint is the most important element of the black-headed grosbeak's food. Scale insects were fed upon by all but 81 of the 226 birds examined.

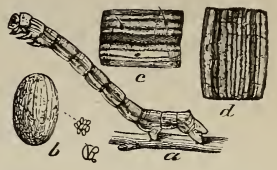

FIG. 35.—Spring cankerworm (*Paleacrita vernata*). (From Riley, Bureau of Entomology.)

The destructiveness of these insects need not be explained to anyone in the western fruit-growing region, where the disastrous effects of their presence have been keenly felt for many years, longer in fact than in any other part of the country. Suffice it to say that scale insects cause more trouble and loss to fruit growers than all other pests combined, and the damage from them is to be reckoned by millions of dollars.

The black-headed grosbeak evinces a distinct preference for the most widely distributed and abundant scale insect on the coast—the black olive scale (*Saissetia oleæ*, fig. 36) the importance of which the following notes from the writings of Prof. E. J. Wickson, of the University of California, will serve to show. It affects both citrus and deciduous trees, but is especially troublesome to the olive, and it will spread quickly to ornamental plants and vines. It is a very difficult scale to subdue, and in spite of the fact that immense numbers are killed by parasites it is still a grievous pest. This insect constitutes 20.32 per cent of the grosbeak's entire food, being eaten by 123 birds, many of which had secured from 12 to 32 scales each. If this service alone is not sufficient to atone for all the bird's depredations on fruit, the latter must be held at an exceedingly high price.

FIG. 36. — Black olive scale (*Saissetia oleæ*). (From Marlatt, Bureau of Entomology.)

Moreover, all has not yet been said in the bird's favor. It does not confine itself to the black olive scale alone, but at times probably preys extensively on other species. Sixteen other grosbeaks consumed enough scales to make up 2.26 per cent of the total food. Among the scales they ate are the brown apricot scale (*Eulecanium armeniacum*) and the frosted scale (*E. pruinosum*), both of considerable economic importance.

The remaining constituents of the animal food have slight percentage value. Fifteen grosbeaks devoured spiders or their cocoons, these items amounting to 0.34 percent of the entire regimen. Among other substances of little importance are snails, eaten by 14 birds, various unidentified insect pupæ by 10, eggshells by 5, and flies by 2; and, most remarkable for a bird of the blackhead's feeding habits, a bit of bone and the remains of a small fish were found in a single stomach each.

Mineral Matter.

The average percentage of mineral matter in the stomachs of the whole number of birds examined is 2.35. The nestlings of 2 or 3 days' age had none; those of a week, 6.57 percent; and those of 2 weeks, only 3 in number, however, had 2.33 percent.

Nestlings.

We are fortunate in having a fair amount of material to illustrate the food habits of the nestling black-headed grosbeaks. The nestlings at hand are readily divisible into three groups, separated both by age and character of the diet. Ten, comprising two broods of 3 each and one of 4, which were collected at the age of 2 and 3 days, had been fed animal matter exclusively. Seven, made up of two broods, numbering 3 and 4 individuals, respectively, had reached the age of 7 and 8 days, at which period a small amount, namely, 2.1 percent, of vegetable food had been introduced into the dietary, while 3 scattered fledgelings of a fortnight's growth consumed an average of 13.3 percent of vegetable substances, mainly fruit.

Two-thirds of the food of the youngest or entirely insectivorous group consisted of caterpillars, much over half of which, to wit, 37.2 percent, was spring cankerworms (*Paleacrita vernata*, fig. 35). In addition, 18 percent was composed of pupæ of the codling moth (fig. 34), which, indeed, were fed to part or all of each brood, including 8 of the 10 nestlings. If the habit of feeding these important pests, on the scale here indicated, to nestlings, whose never-ceasing demands for food are proverbial, is general, the amount of destruction wrought in their ranks is almost incalculable. Besides the codling moth and cankerworm, the flower-beetle and black olive scale also figure in the diet of this lot of youngsters; and longicorn beetles, spiders, leafhoppers, other bugs, and ant pupæ likewise were consumed.

One brood of the second group, which was just being initiated into the use of vegetable food, was given oats in the milk, while the other family was entirely carnivorous. More hard-bodied insects are fed

at this age, beetles composing three-fourths of the whole diet, and over 23 percent was contributed by the flower-beetle alone. Black olive scales are most important among the remaining elements, 12 percent being composed of these pests. Hymenoptera, caterpillars, spiders, and insect eggs also were taken, and each of the members of one brood had a few bits of eggshell in its stomach.

Caterpillars again enter into the diet of the two-weeks old fledgelings, composing 45 percent of the whole amount, 21 percent being cankerworms. Black olive scales are 7 percent, and beetles, including lamellicorns, ground and click beetles, compose 26 percent of the food, the remaining animal elements being Hymenoptera and snails. The vegetable matter, 13.3 percent of the whole food, consists of cherries, strawberries, blackberries, bits of wheat, a few seeds, and spires and wads of grass, which last-named articles curiously enough are found in the stomachs of many other nestling birds.

The oldest fledgelings thus approximate more nearly in diet to that of the adults, even partaking of their fruit-eating habits. It is evident also, from the study of nestling blackheads, that vegetable matter is fed in gradually increasing quantities, corresponding, probably, either as cause or effect, to the growing muscular development of the stomach. Some grosbeaks observed by Professor Beal fed their nestlings only two to five times per hour, but as the feeding was accomplished by regurgitation it is probable that the stomachs of the young were practically filled during every visit to the nest.

Reviewing, it has been noted above that the nestlings of the black-headed grosbeak are fed a great number of codling moth pupæ, cankerworms, flower-beetles, and black olive scales, the destruction of which is greatly to the advantage of agriculture. When very young their food is entirely animal, and consists in great part of these grievous insect pests.

Summary.

Examination of 226 stomachs of the black-headed grosbeak, the majority of which were collected in California, shows that during six months' stay in its summer home the bird consumes on the average 34.15 percent of vegetable and 65.85 percent of animal food.

Reports that the bird damages cultivated fruit are fully sustained by stomach examinations, figs and cherries appearing to be the kinds most injured. From 10 to 15 per cent of the food consists of cultivated fruits; a slightly smaller amount is weed seed, while the proportion of grain devoured is trifling.

It has been brought out that small orchards may be economically protected by means of bird netting. Large orchards may be pro-

tected in great measure by planting here and there suitable decoy trees, as mulberries.

Aside from the fact that ravages by the grosbeak may be prevented or greatly reduced without destroying the birds, it is evident that their general services to agriculture are so valuable that their destruction is not to be considered. It is to be noted: First, that the animal food of the blackhead, consisting almost wholly of injurious insects, is practically twice the bulk of the vegetable food, or more than four times that portion which is pilfered from man. Second, that the bird could not possibly select insects more prejudicial to the interests of western horticulture than the ones forming its natural food. These include the codling moth, cankerworms, flower-beetles, and such scale insects as the frosted, apricot, and black olive scales. Finally, these formidable fruit destroyers alone, not to mention 20 percent of other injurious insects, compose two-fifths of the entire amount of the black-headed grosbeak's food from April to September, or at least three times as much by actual bulk as the fruit consumed. In other words, for every quart of fruit eaten, more than 3 pints of black olive scales and more than a quart of flower-beetles, besides a generous sprinkling of codling moth pupæ and cankerworms fall prey to this grosbeak.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE BLACK-HEADED GROSBEAK.

GRAIN.

Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).

CULTIVATED FRUITS.

Fig (*Ficus carica*).
Mulberry (*Morus* sp.).
Strawberry (*Fragaria vesca*).
Blackberry (*Rubus* sp.).
Crabapple (*Malus prunifolia*).
Apricot (*Prunus armeniaca*).
Cherry (*Prunus cerasus*).
Prune (*Prunus domestica*).

WILD FRUITS.

Juneberry (*Amelanchier* sp.).
Poison oak (*Rhus diversiloba*).
Nightshade (*Solanum nigrum*).
Elderberry (*Sambucus* sp.).

WEEDS.

Dock (*Rumex* sp.).
Smartweed (*Polygonum* sp.).
Pigweed (*Amaranthus* sp.).
Red maids (*Calandrinia menziesi*).
Catchfly (*Silene* sp.).
Chickweed (*Alsine media*).
Cranesbill (*Geranium* sp.).
Alfilaria (*Erodium* sp.).
Bur clover (*Medicago denticulatum*).
Milk thistle (*Mariana mariniana*).

COLEOPTERA.

Tiger beetles (Cicindelidæ):
Cicindela sp.
Ground beetles (Carabidæ):
Platynus variolatus.
Whirligig beetles (Gyrinidæ).
Rove beetles (Staphylinidæ).
Ladybird beetles (Coccinellidæ):
Psyllobora tædata.
Rhizobius ventralis.
Nitidulidæ.
Click-beetles (Elateridæ):
Megapenthes elegans.
Bronzy wood-borers (Buprestidæ):
Buprestis lineata.
Buprestis fasciata langi.
Acmæodera gibbula.
Fireflies (Lampyridæ):
Podabrus sp.
Telephorus consors.
Telephorus divisus.
Lamellicorn beetles (Scarabæidæ):
Aphodius inquinatus.
Euphoria sp.
Long-horned beetles (Cerambycidæ):
Leptura militaris.
Leaf beetles (Chrysomelidæ):
Syncta albida.
Gastroidea cyanea.
Melasoma scripta.
Diabrotica soror.
Diabrotica trivittata.
Darkling beetles (Tenebrionidæ).
Rhynchitidæ:
Deporaus glastinus.
Scarred snout-beetles (Otiorhynchidae):
Scythropus californicus.
True snout-beetles (Curculionidæ):
Dorytomus hispidus.
Baris sp.
Balaninus sp.

HEMIPTERA.

Cicadas (Cicadidæ):
Cicada sp.
Tree-hoppers (Membracidæ).
Scale insects (Coccidæ):
Saissetia oleæ.
Eulecanium armeniacum.
Eulecanium pruinosum.
Leaf-hoppers (Jassidæ).
Jumping plant-lice (Psyllidæ).
Plant-lice (Aphididæ).
Stink-bugs (Pentatomidæ).
Coreidæ.
Plant-bugs (Capsidæ).

ORTHOPTERA.

Short-horned grasshoppers (Acridiidæ).

LEPIDOPTERA.

Spanworms (Geometridæ):
Paleacrita vernata.
Leaf-rollers (Tortricidæ):
Carpocapsa pomonella.

HYMENOPTERA.

Apidæ (*Apis mellifera*).
Rough-headed ants (Myrmicidæ).

DIPTERA.

Borboridæ (*Borborus* sp.).

OTHER INVERTEBRATES.

Spiders (Araneida).
Snails (Gastropoda).

BLUE GROSBEAK.

(*Guiraca cærulea*, Plate IV.)

APPEARANCE, DISTRIBUTION, AND HABITS.

While less strikingly colored than other grosbeaks, this species equals them in beauty. The general color of the male is ultramarine, but the tail and wings are black, with bars of chestnut crossing the latter. The female is much duller. Brownish above and below, with a lighter throat, she bears a marked superficial resemblance to the female cowbird, and the massive bill is the only conspicuous feature that serves to distinguish the two.

This is the smallest of the grosbeaks, and occupies a wider range in the United States than any of the others. There are two subspecies of blue grosbeaks, the western one breeding from southernmost Mexico to northern California and southern South Dakota and the eastern from the gulf coast to southern Pennsylvania and southeastern Nebraska. The two races merge in eastern Texas, Oklahoma, and Kansas. In winter both withdraw entirely from the United States.

During the breeding season the blue grosbeak is locally abundant in the southern and western parts of its range, being in some places a familiar garden and orchard bird. In the eastern part of the Mississippi Valley, however, and in the Atlantic States, it is shy, retiring, and generally rare.

In the latter regions the nest is usually placed in a low bush or vine in a thicket; but where the birds are more common they build in fruit trees or even in cultivated ornamental plants about houses. Everywhere the species nests late. The eggs are 3 or 4 in number and are bluish white; two broods are raised in the south and one in the north. In common with all its relatives, this handsome bird is a good singer, and its song, though weak, suggests the rosebreast's lovely carol. Its pleasing song and engaging appearance have made the grosbeak a favorite cage-bird among the southern creoles, who know it as the "blue pop."

ECONOMIC RELATIONS.

The present investigation of the food habits of this species concerns only summer residents of the United States. Fifty-one stomachs have been examined, which were collected in every month from April to September, inclusive, and in seven States and the District of Columbia. Of the food they contained 67.6 percent is animal matter and 32.4 percent vegetable. No month is represented by more than 19 birds; hence the results obtained are by no means as reliable as could be desired. However, as the economic relations of the blue grosbeak are almost entirely unknown, even these tentative findings have a distinct value.

BLUE GROSBEAKS.

[Top figure, adult male; middle figure, immature male; bottom figure, female.]

Vegetable Food.

The proper valuation of the vegetable elements of a bird's food is of great importance, since upon this point largely depends the attitude of the agriculturist toward the bird. The main question is, Does the blue grosbeak appropriate an undue amount of the product of field, orchard, and garden crops?

Vegetable substances consumed by the blue grosbeak and constituting 32.4 percent of its food may be classified as follows: Grain, 14.25 percent; weed seed, 18.05 percent; fruit, 0.06 percent; and miscellaneous, 0.04 percent.

FRUIT.

From present information it appears that cultivated fruits are not molested by the blue grosbeak. All writers agree that the little fruit eaten is wild, a conclusion supported by the results of the present examination. Only two birds, both young, had eaten fruit of any kind, and in each case it consisted of a few bits of blackberry, undoubtedly wild.

GRAIN.

Grain constitutes 14.25 percent of the food of the birds examined. Wheat was eaten by 6 of the total number, and amounts to 8.33 percent of the entire subsistence. Corn was eaten by 4 birds and is 4.87 percent of the food, while oats, which form 1.05 percent, were consumed by only 2 of the 51 birds. Probably all this grain was obtained from cultivated crops.

One grosbeak, collected in a wheat field in June, had eaten enough of the milky cereal to make up 40 percent of its stomach contents. Three others from the same region in the same and the succeeding two months had devoured wheat, which shows that this grain is relished even in the riper stages.

Apparently the corn in the stomachs also came from the standing crop, and while the blue grosbeak seems too small to be an active depredator of such a well-protected grain, yet with its powerful beak there is no doubt that it can as readily shear through the enveloping husks as crack the kernels themselves. Referring to this latter point, Wilson says of a captive bird: "I fed it on Indian corn, which it seemed to prefer, easily breaking with its powerful bill the hardest grains." Notwithstanding this the bird does little damage. At all events, no complaints of injury have been made.

There is testimony, however, that the bird does some mischief in oat fields. Doctor Fisher, of the Biological Survey, has seen flocks feeding upon this cereal in Nebraska and in California, and the same habit has been observed in Virginia. In general this occurs late in summer. After the nesting season blue grosbeaks change their

habits greatly. The once timorous birds leave off their shyness; the isolated families assemble, and flocks, usually small, but sometimes large, raid the grain fields. Oats and rice especially are injured by them. Concerning the effect of the blue grosbeak upon rice in Louisiana, Mr. George Beyer[a] says: "In the Florida parishes * * * it is generally called 'rice bird.' Flocks of thousands descend upon the ripe rice during August and September." As noted above, oats were found in 2 stomachs examined during the present investigation, rice in none.

Summary.—Only 11 of the 51 blue grosbeaks examined had eaten grain, from which it is evident that this food is not specially sought, even when accessible. Grain constitutes 14.25 per cent of the total food, but only one bird ate grain exclusively. Considering only the 11 cereal feeders, we find they were satisfied with a fare of half grain, and preferred to eat insects and other food along with it. It seems, therefore, that in summer this grosbeak does not evince a decided taste for grain, and, being widely and sparingly distributed, it is inconceivable that noticeable loss can be caused by it.

That the reverse is true later in the year is well established, but the injury then committed seems to be of no great importance, or it would have attracted more attention. It is certain that the blue grosbeak is not for an instant to be ranked with such well-known grain pests as the bobolink and some of the blackbirds, and the cases of serious injury attributable to it are clearly of rare occurrence and brief duration.

Moreover, during by far the greater part of the bird's stay in the United States its food habits are decidedly beneficial, and it consumes almost five times as great a bulk of injurious insects as of grain. Without doubt the farmer could afford to pay for the destruction of these insects with grain in the reverse ratio and yet make a large profit by the bird's services.

WEEDS.

Weed seeds are consumed by the blue grosbeak during every month of its stay in the United States. They constitute 18.05 per cent of the total food, and thus are given preference over all other items of the vegetable regimen. Not a great variety of seeds are devoured, and more of foxtail (fig. 37) and bindweed (fig. 21) are taken than any others. It is well known that these weeds are among the most troublesome in America, striving constantly to overtop and crowd out cutivated plants, while bindweed during its earlier stages harbors the corn root-louse, one of the most injurious of grain pests. Practically all birds to any degree vegetarian feed upon the seeds of these

[a] Avifauna Louisiana, New Orleans, 1900, p. 34.

weeds, a work of which the blue grosbeak assumes a proper share and the value of which in the aggregate is immense.

Before leaving the subject of vegetable food, it should be mentioned that one blue grosbeak, collected in the District of Columbia, had fed largely upon the seeds of wild rice (*Zizania aquatica*). This plant is an important source of food for many larger birds, especially ducks and geese, but is not generally sought by the smaller species.

Animal Food.

The blue grosbeak consumes more than twice as much animal as vegetable food, and it consists of snails, spiders, and various insects. The latter constitute 65.7 out of 67.6 percent, the entire amount, and while comprising for the most part injurious species, include a few forms generally considered useful. These will be discussed at once.

A certain family of ground-inhabiting beetles, the Carabidæ, on account of their predaceous habits, are usually classed as beneficial. They have been detected, however, feeding upon vegetable matter, and in many places even upon cultivated crops. These facts should make us slow to condemn a bird for picking up a few of them. The present species manifests very little liking for ground-beetles, only 4 birds of the entire number having taken them, and in no case did they constitute more than 10 per cent of the stomach contents.

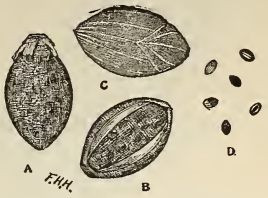

Fig. 37.—Seeds of green foxtail (*Chætochloa viridis*). (From Hillman, Nevada Experiment Station.)

One other predaceous insect was captured. This was a robber fly (Asilidæ). Flies of this family capture grasshoppers, beetles, other flies and bees, and at times do considerable mischief among honey bees. They are not wholly beneficial, therefore, although probably the balance is in their favor. If it is the rule, however, as appears from the present examination, that not more than 1 blue grosbeak in 50 takes a robber fly, the resulting damage need not disturb us.

Besides the insects of predatory habits, there are others which are useful as parasites. None of these were taken directly by any of the blue grosbeaks examined, but about 20 eggs of a parasite, probably a tachina fly, were attached to the body of a purslane caterpillar eaten by one of the birds. Had these parasitic flies been allowed to complete development they would have attacked and destroyed other caterpillars, but probably not so many as the grosbeak which fed upon them, one-tenth of whose food would have consisted of these creatures.

Caterpillars and adult lepidoptera (moths) compose 9.77 percent of the food of the blue grosbeak. The purslane caterpillar (fig. 38) mentioned above is eaten by adults and is fed also to the nestlings.

Ordinarily this insect is harmless, but occasionally it attacks garden and fruit crops, especially the sugar beet. Another caterpillar also, the cotton cutworm (*Prodenia ornithogalli*, fig. 9), which attacks the latter crop as well as the tomato and cotton, is devoured by the blue grosbeak. Four birds, taken in the cotton fields of Texas in May, had eaten 9 cotton cutworms, which constituted more than 40 percent of their food. Many other caterpillars also of the same family (Sphingidæ), as the purslane feeder, and two moths were consumed by the blue grosbeaks examined. Because of the injurious

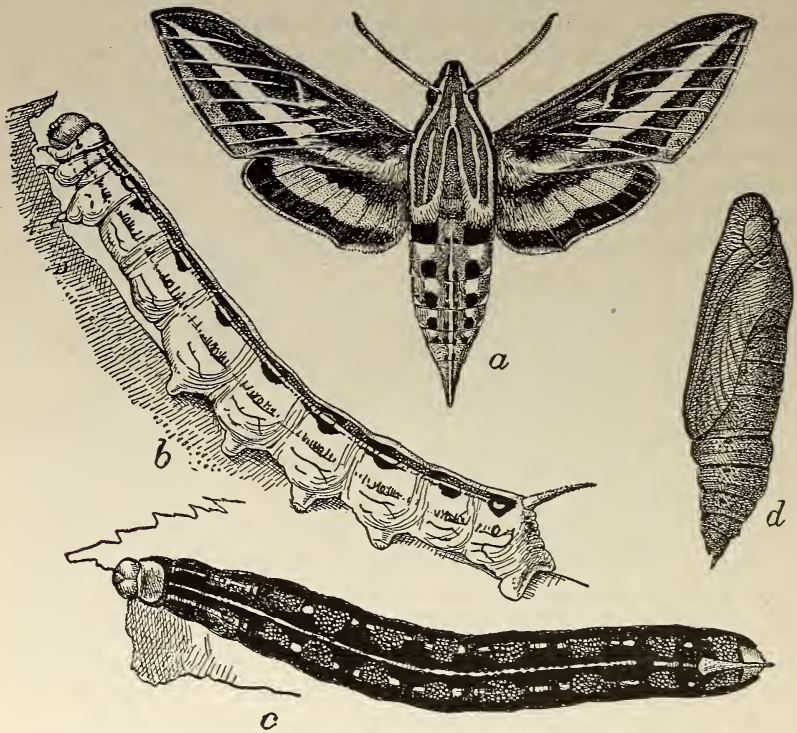

FIG. 38.—Purslane caterpillar (*Deilephila lineata*). (From Chittenden, Bureau of Entomology.)

habits of these insects their destruction by the grosbeak is to be commended.

The true bugs (Hemiptera) constitute another group of insects, mainly injurious, and all of them eaten by the grosbeak are destructive. These include members of the squash-bug family (Coreidæ), stink-bug family (Pentatomidæ), tree-hoppers (Membracidæ), and cicadas or harvest flies (Cicadidæ). One blue grosbeak from South Dakota had eaten 3 of the latter, which composed 94 percent of its stomach contents.

Injurious beetles comprise 24.4 percent of the grosbeak's food, almost half (11.25 percent) of which amount consists of members of the May beetle family (Scarabæidæ). Adult June bugs, and their larvæ, the white grubs, were devoured by some birds to the exclusion of other food, and 1 grosbeak had eaten 3 of the common dung-beetles (*Aphodius fimetarius*). Weevils are next in importance among beetles, and 7.18 percent of the bird's seasonal food was made up of these pests. Many of them were scarred snout-beetles (Otiorhynchidæ) and curculios (Curculionidæ); some of them certainly were injurious species. Two grosbeaks selected the conspicuously red and black colored billbug (*Rhodobænus 13-punctatus*), each eating 2. Leaf-beetles (Chrysomelidæ), wood-borers (Buprestidæ), click-beetles (Elateridæ), and long-horned beetles (Cerambycidæ), nearly all of which are injurious, were also devoured.

The most important element of the animal food, however, is grasshoppers. Crickets and long and short horned grasshoppers are eagerly consumed, composing 27.2 percent of the total food. Thirty-two of the 51 blue grosbeaks ate them, several taking nothing else. They are fed to the nestlings in generous measure, and without doubt are the most important single article of diet. During one of the historic outbreaks of the Rocky Mountain locust, the blue grosbeak was found to feed on other grasshoppers among the swarming hordes, and it is certain that the pest itself was not overlooked. A very closely-related species, called in contradistinction the lesser migratory locust (*Melanoplus atlanis*, fig. 39), has been identified from the stomachs examined.

FIG. 39.—Lesser migratory locust (*Melanoplus atlanis*). (From Lugger, Minnesota Experiment Station.)

But little insect food in addition to that above discussed is consumed. A fly or a wasp is rarely secured, and one ant and a sawfly larva were eaten. Besides insects, a small amount of other animal matter was present in the stomachs. Spiders or their egg-sacs were eaten by 2 birds and snails by 9. The latter may be taken in lieu of gravel.

MINERAL MATTER.

Only 2 adult blue grosbeaks out of a total of 38 had taken inorganic mineral matter, and the percentage of such material is only 0.63. Of 13 nestlings, 7 contained mineral matter in quantity sufficient to make the average for the whole group 8.3 percent, which is

more than 13 times as much as the old birds take. So wide a discrepancy would seem to indicate that there is great difference between old and young birds in the need for this material.

Young.

Among the blue grosbeaks examined are 13 young collected in Kansas in July and August. Eight of these are nestlings, and 5 are young just out of the nests, but still being fed by their parents. The percentage of animal food for the 13 young birds is 99.08; of vegetable, 0.92.

Grasshoppers constitute 74.1 percent of the food. Among them are included the lesser migratory locust (*Melanoplus atlanis*) and a large coral-winged locust (*Hippiscus*, fig. 40). The remains of as many as 16 short-horned locusts were obtained from one stomach, while another contained 14. Caterpillars, among them the purslane sphinx, compose 10.7 percent of the subsistence of the nestlings, and

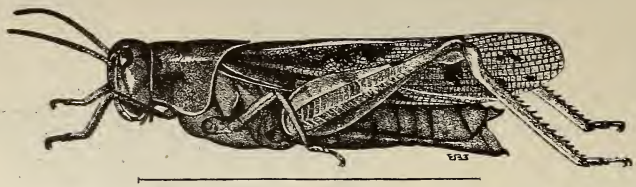

Fig. 40.—Coral-winged locust (*Hippiscus tuberculatus*). (From Lugger, Minnesota Experiment Station.)

snails 10 percent. The remainder of the animal food consists of a weevil, a long-horned beetle, a ground beetle, a robber fly, and the eggs of a tachina fly, which were on the purslane caterpillar. It is curious that so large a proportion of the beneficial insects consumed should be in the stomachs of nestlings, but it may be that these items, which ordinarily are rarely taken, are hurriedly gathered only because of the insistent demands of the hungry young.

The vegetable food consists of a few unidentified vegetable filaments and some slight remains of blackberries in two stomachs; this was the only fruit eaten by any of the birds, young or old.

Summary.

Present data shows that the food of the blue grosbeak is 67.6 percent animal and 32.4 vegetable.

Grain constitutes 14.25 percent of the diet, but on account of the scattered distribution of the birds, no appreciable damage is done during most of the summer. Later, when they forage in flocks, they are said to do considerable injury. But, as noted above, the birds consume twice as much animal as vegetable matter, and even if all of the latter had been grain, instead of less than half, as is actually the case, it would have been paid for many times over.

Among the important insect pests eaten by the blue grosbeak are grasshoppers, weevils, the purslane sphinx, and the cotton cutworm. The species deserves protection for its destruction of grasshoppers alone, and when its food habits are considered in their entirety the showing unquestionably is greatly in favor of the bird.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE BLUE GROSBEAK.

GRAIN AND FORAGE PLANTS.

Corn (*Zea mays*).
Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).
Alfalfa (*Medicago sativa*).

WEEDS AND WILD FRUIT.

Crab-grass (*Panicum* sp.).
Yellow foxtail (*Chætochloa glauca.*)
Green foxtail (*Chætochloa viridis*).
Wild rice (*Zizania aquatica*).
Rush grass (*Sporobolus* sp.).
Smartweed (*Polygonum* sp.).
Blackberry (*Rubus* sp.).

COLEOPTERA.

Ground-beetles (Carabidæ).
Click-beetles (Elateridæ).
Leaf-beetles (Chrysomelidæ).
Bronzy wood-borers (Buprestidæ).
Lamellicorn beetles (Scarabæidæ):
Aphodius fimetarius.
Lachnosterna sp.
Long-horned beetles (Cerambycidæ):
Hippopsis lemniscata.
Scarred snout-beetles (Otiorhynchidæ).
True snout-beetles (Curculionidæ).
Bill-bugs (Calandridæ):
Rhodobænus 13-punctatus.

HEMIPTERA.

Cicadas (Cicadidæ):
Cicada sp.
Tree-hoppers (Membracidæ).
Squash-bugs (Coreidæ).
Stink-bugs (Pentatomidæ).

ORTHOPTERA.

Short-horned grasshoppers (Acrididæ):
Hippiscus sp.
Melanoplus atlanis.
Long-horned grasshoppers (Locustidæ).
Crickets (Gryllidæ):
Gryllus sp.

LEPIDOPTERA.

Hawk-moths (Sphingidæ):
Deilephila lineata.
Owlet-moths (Noctuidæ):
Prodenia ornithogalli.

OTHER INSECTS.

Smooth-headed ants (Formicidæ).
Sawflies (Tenthredinidæ).
Robber flies (Asilidæ).
Tachina flies (Tachinidæ).

OTHER INVERTEBRATES.

Spiders (Araneida).
Snails (Gastropoda).

RELATIONS OF GROSBEAKS AND OTHER BIRDS TO PARASITIC INSECTS.

As in the previous pages mention is made of the fact that grosbeaks to some extent feed on parasitic insects, and as many other birds have the same habit, certain phases of the subject are here briefly discussed. Parasites are useful to man because they prey upon and reduce the numbers of injurious insects. Hence to the extent that birds diminish the number of parasites they are inimical to man's interests. But there is another aspect to the interrelations of birds, parasites, and injurious insects. The attacks of parasitic insects, however numerous they may be, do not result in the immediate death of their victims, since time is required for the development of the larvæ within or upon the body of the hosts. Hence the latter, after receiving the eggs which ultimately are to prove fatal, sometimes continue their depredations, and may in a few days ruin the season's crop. Under these circumstances the parasites do no immediate good, though they serve to prevent increase of the species attacked. It is quite otherwise with birds, which instantly stop depredations by killing the insects responsible for them. Often in a few days birds extirpate a pest over a limited area, and the crop, freed from its enemies, makes successful growth. It is true that at the same time all eggs and larvæ of parasites present in the host insects also are destroyed. Though this is regrettable, the effects of the loss of the parasites must be regarded as of secondary importance, since the main purpose—getting rid of the pests—is accomplished.

Precisely the same result follows the destruction of cocoons, the burning of caterpillar nests, fumigation by hydrocyanic gas (which is exceedingly destructive to all life), and wholesale killing by contact sprays (kerosene, whale-oil soaps, and the like). These methods of destroying insects are widely recommended and extensively used, resulting in the indiscriminate destruction of beneficial and injurious insects, foe and friend alike. Moreover, there is no doubt that in spite of their indiscriminate effect, these practices result in great good. As stated above, birds are chargeable with similar destruction of useful insects along with the injurious, but it is worthy of note that the effects of their feeding have not been judged from the same standpoint nor given the benefit of doubt accorded to the work of artificial agencies. However, since it has been suggested that birds may so reduce the number of parasitic insects as seriously to restrict their beneficial services, it may be profitable to inquire into the facts of the case. There is no record of an instance in which noticeable injury has been caused through the destruction of parasites by birds, and there is much evidence going to show that this never happens. First, taking

up the order Diptera, to which belong the tachina parasites (such as were found in the stomach of one blue grosbeak), the data now available show that probably less than 3 percent of the food of birds in general consists of members of this order. And there is no reason to believe that parasitic forms of this or other orders are specially sought for by birds. Since the dipterous parasites are confined to three or four families of the three score in the United States, it is not likely that the part of the 3 percent of bird food they furnish results in much injury to agriculture.

Turning to that most important group, the Hymenoptera, it is to be noted that many of them are small, some being extremely minute (as is the case with a large group of the most effective parasites, the chalcis flies), and these are very rarely found in bird stomachs. A few families of Hymenoptera (Chrysididæ, Trigonalidæ, Sapygidæ, and Mutillidæ) are characteristically parasitic on other and useful members of the order. The destruction of any of these by birds (the cuckoo-flies are taken, at least occasionally) is a benefit. The same must be said of the capture of many species belonging to other families which are guilty of the same practice. They parasitize their beneficial relatives, often destroying a large proportion of them. Moreover, even the species usually beneficial do not always stick to their rôles, but sometimes parasitize species having the same as their own normal relation to the host. All of these things tend to mitigate the injury done by birds that feed on Hymenoptera. The facts at hand show that, excluding ants (which are in no way concerned with parasites), Hymenoptera compose not more than from 3 to 5 percent of bird food in general. Of the insects composing this percentage, according to our identifications, nonparasitic forms outnumber the parasites in the proportion of about 4 to 1. Hence at most not more than 1 percent of the food consumed by all the members of our avifauna consists of parasitic Hymenoptera, taken as free-moving forms.

Proceeding now to the main point at issue, whether great numbers of parasites in the egg or larval state are eaten by birds along with the usual prey, the following statements can be made. The parasites in insect eggs (which include very many of the large superfamily Proctotrypoidea, and some others) are absolutely safe from the majority of birds, only the smaller titmice, warblers, etc., searching much for eggs. Parasites also in the cocoons and chrysalids are comparatively secure, as only few birds consume these objects. The parasites of all minute insects, like egg parasites, are exempt from danger, except from a certain contingent of the smaller birds. The parasites living upon medium-sized caterpillars, beetle larvæ, and adult insects, however, run considerable risk of becoming bird food. But even members of this group are in a measure favored, since a good proportion of the caterpillars or other insects they infest are not

likely to be eaten by birds, both because they are usually discolored or otherwise abnormal in appearance and because often they are inactive, and hence escape attention. It should be stated, however, that freshly parasitized individuals are of normal appearance, and whether or not they are recognized by birds, it is certain that in the stomach such caterpillars can not be distinguished from the uninfested.

However, it is certain that, in spite of this difficulty of recognizing recently parasitized larvæ, a well-defined tendency on the part of birds to avoid these doomed insects is shown by the wholly insignificant number found in which parasitism is evident. Only the one parasitized caterpillar mentioned above, and one other eaten by a hawk, have been found in more than 40,000 stomachs examined by the Biological Survey. Hence it would seem that serious diminution in the ranks of parasites is much more logically explained by some other cause, such as the well-known pernicious activities of certain hyperparasites, than by the attacks of predaceous foes. The following extract[a] from "A Study of the Hymenopterous Parasites of the American Tent Caterpillar," by W. F. Fiske, serves to show the possibilities of this hyperparasitical activity.

> In 1896 it [the tent caterpillar] was exceedingly common, so much so as to attract attention all over the State, and it was consequently assumed that its parasites would also have increased to such an extent as to be a considerable factor in bringing about a more normal condition in 1897. But strangely enough this reasoning was found to be diametrically opposite to the facts of the case. In 1896 a great many caterpillars were destroyed by *Limneria fugitiva* [a parasite], and numbers of the characteristic cocoons of this species were collected and bred at this station. These proved in their turn to be almost entirely the prey of *Pimpla inquisitor* [a hyperparasite], and the breeding cages in which the cocoons were confined becoming filled with the adults of the hyperparasite, it was mentioned in the report of the year, and given credit for the destruction of large numbers of tent caterpillars. Thus it was the *Limneria* which proved to be the real victim, and as its cocoons were rare the next year the primary host, *Clisiocampa americana* [the tent caterpillar], was indirectly but decidedly the gainer.
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> As one season's observations succeeded another's this case from being an exception, as was at first thought, was found to be more nearly the rule. The comparative abundance of the tent caterpillars varied greatly, it is true, but this was obviously due to other and distinct causes than this under discussion, and only a certain percentage, varying considerably from one colony to another, or to a less degree between different localities, fell a prey to the hymenopterous parasites. The parasites as a body were found to exact a certain tithe of blood, so to speak, and this being obtained would proceed to fight over its possession, passing it from one to another, from parasite to hyperparasite, until often, perhaps, there would be little more than enough left of a single large caterpillar than that sufficient to support a single small Chalcid.

It is evident from these statements that we need look no further for the enemies which so check the useful services of parasites.

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[a] Tech. Bull. 6, N. H. Agr. Exp. Sta., 1903, pp. 185–186.

Comparisons of the usefulness of parasitic insects and of predaceous species, both insects and birds, have been made to the disparagement of the latter class and in consequence the benefits conferred by parasites have sometimes been exaggerated. But in weighing the importance of these statements it should not be forgotten that essentially parasites are dependents. It is farthest from their object to exterminate their hosts, even in a limited area. This result, which in most cases means disaster to the parasite, is, on the other hand, of but little moment to predaceous insects or birds. The latter always have a wide range of prey and even if one food supply is exhausted usually there are others at hand. The best evidence that predaceous foes of insects are worthy of as high consideration as parasitic ones is afforded by the instance of the extermination, successively, by the ladybird, *Novius cardinalis*, of the cottony cushion scale in California, of the fluted scale in South Africa, and of a congeneric scale insect in the gardens of Alexandria, Egypt. These are absolutely the most important services in destroying insects ever rendered to man and were accomplished by a predaceous enemy which is chargeable with the same lack of nice discrimination with respect to parasites attributed to birds.

However, there is no necessity for belittling the services of either of the two great classes of pest destroyers. Both consume a certain proportion of insects directly injurious to man and it is more than likely that either would be hindered rather than helped by the absence of the other. Everything, indeed, points to the conclusion that from the standpoint of man's welfare the loss of either class would irreparably disturb the balance. What has been said by a noted entomologist concerning parasites, namely, that the presence of both parasites and hosts, continuing through thousands of years to the present, implies that an equilibrium is maintained enabling each to live, is just as true of predaceous enemies, both in relation to parasites and to their common prey. There can be no doubt that, even under the greatly changed conditions induced by man, the interactions of these classes tend directly toward the establishment and maintenance of a balance. It is probable that this balance can be secured at a lower level in regard to number of individuals only by direct reduction of the injurious species by man, coupled with the best possible protection of both their predatory and parasitic enemies.

GENERAL CONCLUSION.

With respect to food habits it appears that the grosbeaks form a group apart from the majority of the finch family, to which they belong. The members of this group are by no means the extreme vegetarians they are commonly supposed to be, since on the average they consume about 25 per cent of animal food. The grosbeaks, however,

are even less exclusively vegetarian than others of the family and nearly half their food is animal. Moreover, the constituents of the animal dietaries of the two groups differ considerably. Nearly all finches hitherto examined have been found to avoid hairy caterpillars, but the grosbeaks eat them eagerly. True bugs generally are neglected by the smaller members of the sparrow tribe, while the grosbeaks consume on an average 7.25 percent of these strongly flavored insects. Further, while caged and hungry individuals of some of the smaller sparrows refused both the Colorado and three-lined potato beetles, cucumber and ladybird beetles, and also stinkbugs of the genus *Euschistus*, each of these insects is captured in the open by one or more, if not all, of the grosbeaks. In fact, the so-called protected fireflies, leaf beetles, and ladybirds, as also hairy caterpillars and the adaptively colored or distasteful bugs and scale insects, seem poorly defended, for all of them serve as grist for the grosbeak mill. A difference between the vegetable dietaries of the grosbeaks and other sparrows is also worthy of notice. Weed seeds form half of the annual food of the latter group, while only one of the grosbeaks devours so large a proportion, the others consuming an average of about 18 percent.

To the grosbeaks in particular, as to the sparrow family as a whole, general traits have been ascribed as characteristic which investigation fails to substantiate. For instance, the grosbeaks are found to have no special predilection for buds, notwithstanding popular opinion to the contrary. Then, too, it is generally considered that the massive grosbeak bill is especially designed to crack hard fruits and seeds, and it would appear certain that in some way it is related to peculiarities of food. Yet the smaller sparrows and the cowbirds, with much weaker bills, break all sorts of seeds as readily as the cardinal. Indeed, the food habits of the grosbeaks, as revealed by the present investigation, offer no clue to the origin of the form of bill. Its great crushing capacity appears to be utilized only on rare occasions, one cardinal, for instance, out of 500 eating a hickory nut. Practically all the food eaten by grosbeaks seemingly could be manipulated just as readily by birds with comparatively slender beaks. It is true that the curiously curved beak of the parrot-bill may be useful in securing the much relished seeds of bur grass (*Cenchrus*), but the same kind of seeds is eaten also by the straight-beaked cardinal. No doubt there is an intimate connection between the size and form and the function of the grosbeak bill, but for the key apparently we must look to past conditions of environment, for its extraordinary size and shape appear to answer no present needs.

Notwithstanding also the general similarity of bills, as well as of other points of structure, the five grosbeaks differ considerably in food habits. This divergence is beneficial to the birds, no doubt, when they

occupy the same general territory, since it keeps them apart when foraging, each thus securing enough food without competing too strenuously with its neighbor. It is of great value also to man, because the birds exact tribute from the whole field of his insect enemies.

As would be expected, the cardinal and gray grosbeaks have somewhat similar tastes. They rank highest of the group as seed eaters; they consume little grain, capture a very small number of Hymenoptera, and relish weevils best among beetles and grasshoppers among other insects. The cardinal alone is very fond of wild fruit, the place of this item in the regimen of the gray grosbeak being filled by a corresponding quantity of weed seed. The rose-breasted and black-headed grosbeaks also have similar preferences, each manifesting indifference toward grasshoppers but each relishing Hymenoptera and true bugs. Fruit is held in about the same estimation by the two birds, though the blackhead is much more injurious to cultivated varieties. Both it and the rosebreast make a specialty of leaf-beetles, each selecting a single species as one of its most favored foods. The blackhead pays slight attention to grain and weed seed, but feeds ravenously on scale insects; and the rosebreast, while by no means neglecting scales, feeds more extensively on cereals and seeds. The blue grosbeak is peculiar in three respects: It shows a very strong liking for grasshoppers, for lamellicorn beetles, and a maximum avidity for grain; and it is like the gray grosbeak in almost totally neglecting fruit.

Preferences such as the above explain why one species attacks particular crops which the others never touch. Thus, from the standpoint of the fruit grower the blue grosbeak is entirely beneficial, but the grain grower sometimes has reason to execrate this species, while to him, the blackhead, which injures the fruit of his neighbor, seems innocent. But as has been shown in preceding pages the beneficial qualities predominate in both birds and "it is well to remember," as is wisely said by Wilson Flagg,[a] "that nature does not grant us a benefit without taking some compensation. We must be content to pay for the services of our useful birds by allowing them as a perquisite a certain portion of the fruits of our soil. We must pay the crow and blackbird in corn, and the robin and the cedar bird in cherries; and if it be objected that the robin tax falls disproportionately upon the fruit growers, so, on the other hand, the blackbird tax falls disproportionately upon the farmer and the corn grower. These evils, except as they can be prevented by watchfulness and ingenious contrivances that do not harm the bird, must be patiently endured for the common good."

[a] Ann. Rep. Mass. Bd. Agr. (1861), 1862, Appendix, p. 76.

Looking beyond the confines of the individual orchard or grain field, it is apparent that the grosbeaks make small demands either on our patience or endurance. The brief season of crop pilfering is a comparatively insignificant part of the otherwise beneficial yearly life of the grosbeaks, a fact sometimes lost sight of. The importance of birds as checks upon the insect enemies of agriculture, and the fact that they are among the most valuable assets of the farm, are too well known to require proof. No one should be so blinded to his own best interests by a sense of present injury as to destroy by wholesale creatures which by every intent and provision of nature are among his best friends. The destruction of the most grievous pests known to us by birds give them a value comparable in degree, if not in kind, with that of some of the useful domestic animals, and when they are caught in mischief, they should be dealt with on the same principle as domestic stock, that is, with a view of preserving them for future service. Farm animals are not destroyed when they commit devastations; measures are taken to protect the crops from future raids by strengthening weak and broken fences. Similarly, crops should be protected against the raids of birds, and experiments have demonstrated that bird netting, tarred seed, and decoy fruit trees, among other things, may successfully be employed to this end, while at the same time the birds are preserved to turn their energies to better account in destroying insect pests.

No group of birds better deserves to be treated in this fair and practical way than the grosbeaks. The details of their useful habits, as given in the preceding pages, need not be repeated, but since a final estimate of the value of the group depends upon the exact nature of the food of its several members and their relation to agricultural interests, it is proper to restate general conclusions: The five grosbeaks studied consume on the average nine times more weed seed than grain and fruit. Moreover, they devour nineteen times more injurious than useful insects. Consequently, since their subsistence is about half animal and half vegetable, their food habits are about fourteen times more beneficial than injurious. It has been shown, furthermore, that they attack many destructive insects, even specializing on some of the greatest pests. The grosbeaks, therefore, making due allowance for the injury they do, are of great economic value, and it is evident that the farmer will derive great advantage by preserving them.

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